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RADIOLOGICAL HEALTH DATA AND REPORTS

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In August 1959, the President directed the Secretary of Health, Education, and Welfare, to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels such as natural background, radiography, medical and industrial uses of isotopes and X rays, and fallout. The Department delegated this responsibility to the National Center for Radiological Health, Public Health Service.

Radiological Health Data and Reports, a monthly publication of the Public Health Service, includes data and reports provided to the National Center for Radiological Health by Federal agencies, State health departments, and foreign governmental agencies. Pertinent original data and interpretive manuscripts are invited from investigators.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service • National Center for Radiological Health

Reports

PLUTONIUM-239 IN TOTAL DIET AND MILK

P. E. Kauffman and *P. J. Magno*[1]

The National Center for Radiological Health initiated a program in July 1965 to determine the level of plutonium–239 in the total diet and milk. The diet samples were obtained from the Institutional Total Diet Sampling Network of the Public Health Service and the milk samples were obtained from the PHS Pasteurized Milk Network. Using a gastrointestinal absorption factor of 3×10^{-5} as suggested by the International Commission on Radiological Protection, the average amount of plutonium–239 reaching the blood stream from the diet is estimated to be 2×10^{-4} femtocuries per day.

Radionuclides of plutonium have been introduced into the environment during past atmospheric weapons testing, and also from the burnup of the SNAP–9A satellite which used plutonium as a power source (*1*, *2*). As part of its program to assess radiation exposures from food intake, the National Center for Radiological Health initiated a program in July 1965 at the Northeastern Radiological Health Laboratory to determine the levels of plutonium–239 in the total diet and milk.

The diet samples analyzed as part of this program were obtained from the Institutional Total Diet Sampling Network (ITDSN) of the Public Health Service. The ITDSN was originally designed to estimate the dietary intake of radionuclides in a selected population group ranging from children to young adults (*3*). In July 1965, when the plutonium sampling program was initiated so the institutions sampled included only children from 9 to 12 years of age (*4*). The milk samples analyzed were obtained from the PHS Pasteurized Milk Network (PMN), whose stations are selected to provide nationwide surveillance of milk-production and consumption areas (*5*).

[1] Mr. Kauffman is program coordinator, Analytical Quality Control Service; and Mr. Magno is chief, Heavy Elements Section; Northeastern Radiological Health Laboratory, Public Health Service, Winchester, Mass. 01890.

Sample collection

For the purposes of this study, the United States was divided into six regions: Northeast, South, Delta, Central, Southwest, and Northwest. Monthly samples from each of the ITDSN and PMN sampling stations were composited and analyzed according to these regions. Figure 1 shows the ITDSN and PMN sampling stations in each of the designated regions.

Analytical methodology (*6*)

The samples were dry-ashed at 525°C. Plutonium–236 was added as a tracer and the ash leached with nitric acid. Any insoluble residue was ignited in a muffle furnace at 600°C. and then fumed with hydrofluoric and perchloric acids. The remaining salts were dissolved in hydrochloric acid and this solution combined with nitric acid leach.[2] Plutonium was then reduced to the +3 oxidation state with hydroxylamine hydrochloride and coprecipitated with the alkaline earth phosphates by addition of ammonium hydroxide. The alkaline earth phosphate precipitate was dissolved in 7.2M nitric acid and the plutonium oxidized to the +4 state with sodium nitrite. The solution

[2] In the analysis of the total diet samples, a very small residue remained after this treatment and was discarded.

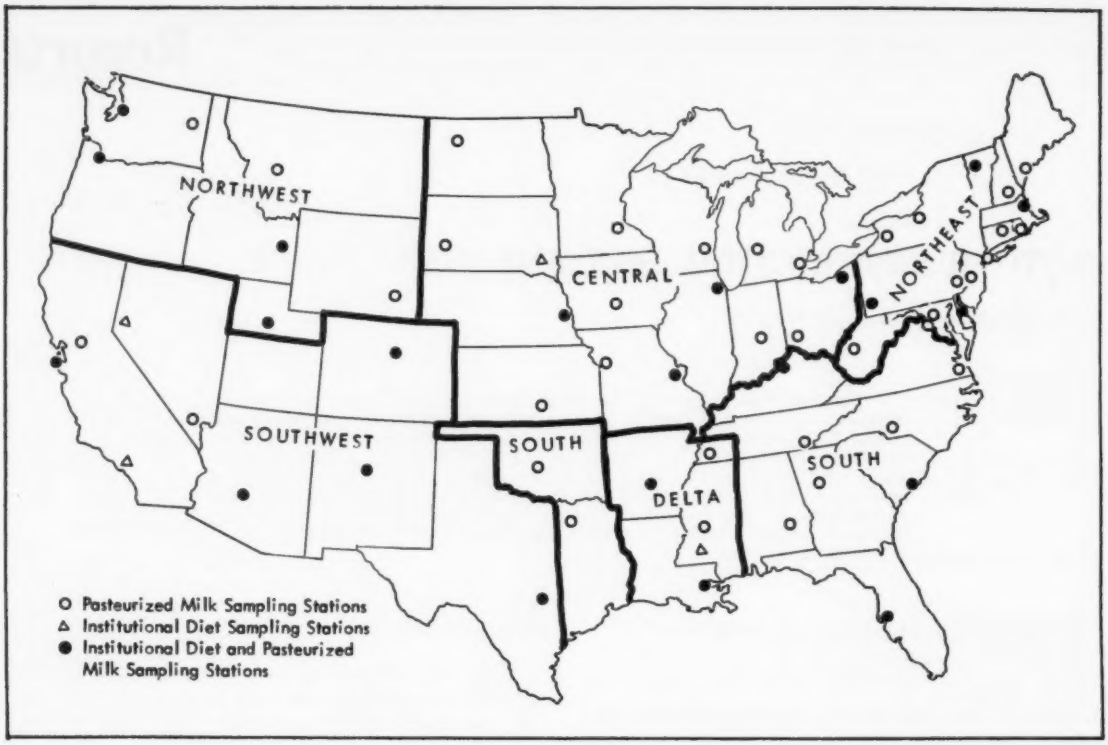

Figure 1. Pasteurized milk and institutional diet sampling stations according to regions used for plutonium composites

was then passed over an anion exchange resin in the nitrate form. The resin was washed with additional 7.2M nitric acid and then with 9M hydrochloric acid. The plutonium was eluted from the resin with a mixture of 0.36M hydrochloric acid and 0.01M hydrofluoric acid, electroplated onto a stainless-steel planchet from a sulfuric acid—ammonium sulfate electrolyte, and counted in an alpha-particle spectrometer.

The energies of the alpha particles from plutonium–239 and plutonium–240 are not sufficiently different to be separated by alpha-particle spectrometry. Therefore, when plutonium–239 is referred to in this report, it represents the sum of the activities of plutonium–239 and plutonium–240.

The samples were usually counted for at least 1,000 minutes. Reagent blanks containing plutonium–236 tracer were run concurrently with the samples. The alpha-particle activity of plutonium–239 was converted to femtocuries (fCi or 10^{-15} curies) of the radionuclide per sample from the following equation:

$$^{239}\text{Pu} = \frac{(A-B)C}{(D-E)}$$

^{239}Pu = fCi per sample of plutonium–239

where,

A = gross counts per minute (CPM) in plutonium–239 spectral region,

B = reagent blank counts per minute in plutonium–239 spectral region,

C = fCi plutonium–236 added,

D = gross counts per minute in plutonium–236 spectral region,

and,

E = background counts per minute in plutonium–236 spectral region.

A silicon surface barrier detector with an active area of 4.5 cm^2 was used. With the sample electroplated onto a 3.1 cm^2 area, the

counting efficiency was 31 percent and the resolution 75 keV (full width half maximum).

Results

Tables 1 and 2 present the results of the analyses of plutonium–239 in the composited monthly samples of milk and of food collected in each region from July to December 1965. The analytical error for each determination (which at these levels consists of only the counting error) is given. The analytical errors presented in this article for the average for each region and the overall averages were calculated from the errors for the individual samples by standard propagation-of-error techniques, as indicated in the tables.

The data in table 1 show that the concentrations of plutonium–239 in milk in each of the six regions were generally less than their associated analytical error which ranged from approximately 1 to 6 fCi/kg.

The data in table 2 show that the concentrations of plutonium–239 in the total diet samples were often detectable above background, with the maximum value being 9.3 ± 4.2 fCi/kg. The average values from the six regions ranged from 2.7 ± 2.3 to 5.8 ± 1.7 fCi/kg; and the overall average value for the 34 samples analyzed was 3.8 ± 0.9 fCi/kg. It should be noted that all these values include the diluting effect of the milk component of the diet. The plutonium–239 concentrations of the non-milk portions of the diet would be somewhat higher than those indicated here.

Dietary intakes for plutonium–239 are presented in table 3 and were obtained by multiplying the ITDSN food consumption rate (*7*) in kg/day times the concentrations given in table 2. The maximum observed dietary intake was 18.1 ± 8.1 fCi/day. The average values for the six regions for July–December 1965 ranged from 5.0 ± 4.1 to 10.8 ± 3.2 fCi/day, with an overall average of 7.0 ± 1.6 fCi/day.

Table 1. Plutonium-239 in PMN composite milk samples, July–December 1965

Region	Plutonium-239 [a] concentrations ±E [b] (fCi/kg)					
	July	August	September	October	November	December
Northeast	1.0±1.4	[c]	3.5±3.5	[c]	[c]	1.9±1.6
South	0.2±1.1	0.0±1.1	3.1±4.2	[c]	0.2±1.1	0.0±0.9
Delta	0.0±5.0	[c]	2.8±4.7	[c]	[c]	[d]
Central	0.4±1.3	[c]	0.9±1.8	[c]	0.4±2.1	0.1±0.9
Southwest	0.4±2.4	0.0±6.2	[c]	[c]	2.2±2.1	0.4±1.2
Northwest	[c]	1.5±4.3	[c]	[c]	0.2±1.0	0.0±1.8

[a] Represents plutonium-239 and plutonium-240.
[b] E, analytical error (2σ counting error).
[c] Observed values were less than background.
[d] Sample lost.
[e] Sample not received.

Table 2. Plutonium-239 in ITDSN composite institutional diet samples, July–December 1965

Region	Plutonium-239 [a] concentrations ±E [b] (fCi/kg)						
	July	August	September	October	November	December	Average
Northeast	7.0±5.0	6.4±3.5	5.2±2.8	[c]	1.2±6.3	[c]	[d] 2.7±2.3
South	6.7±5.1	4.8±7.8	2.2±6.5	7.7±4.7	[c]	6.1±3.0	4.5±2.1
Delta	2.0±2.9	0.9±5.0	3.2±4.4	7.9±8.8	0.6±3.1	[d]	2.9±2.4
Central	3.2±3.1	1.2±3.5	8.5±5.5	[c]	1.0±5.5	9.3±4.2	3.6±2.0
Southwest	4.8±5.0	1.9±3.1	[c]	2.2±4.5	2.4±4.8	4.8±3.5	3.2±1.9
Northwest	7.3±5.4	4.2±2.5	5.4±3.3	3.4±5.5	5.5±3.3	8.8±4.2	5.8±1.7

[a] Represents plutonium-239 and plutonium-240.
[b] E, analytical error (2σ counting error).
[c] Observed values were less than background. The actual negative numbers obtained were used in computing the average to avoid a statistical bias. They are given below:

Northeast:	October	−1.4±5.2 fCi/kg
	December	−2.2±9.5
South:	November	−0.3±1.4
Central:	October	−1.8±6.9

[d] The analytical error of the average value was calculated using the formula:

$$E(\text{avg}) = \frac{\sqrt{\Sigma(E)^2}}{n}$$

[e] Sample lost.

Table 3. ITDSN dietary intake of plutonium-239, July–December 1965

Region	Plutonium-239 [a] intake ± E [b] (fCi/day)						
	July	August	September	October	November	December	Average
Northeast	12.9±9.2	12.9±7.1	10.9±5.9	[c]	2.5±13.2	[c]	[d] 5.3±4.8
South	10.7±8.1	9.1±14.9	3.5±10.3	13.4±8.2	[c]	10.5±5.2	7.8±3.7
Delta	4.5±6.5	1.9±10.6	5.5±7.6	11.8±13.1	1.2±6.3	[c]	5.0±4.1
Central	6.0±5.8	2.4±7.0	14.6±9.5	[c]	1.9±10.0	18.1±8.1	6.6±3.7
Southwest	9.3±9.7	3.2±5.3	[c]	4.3±8.8	4.5±9.0	9.3±6.8	6.1±3.6
Northwest	14.1±10.4	8.5±5.1	10.0±6.2	6.3±10.1	10.0±6.0	15.8±7.6	10.8±3.2

[a] Represents plutonium-239 and plutonium-240.
[b] E, analytical error (2σ counting error).
[c] Values less than zero. The intakes representing these analyses result from the negative (less than background) concentrations observed. The actual negative intakes calculated were used in compositing averages to avoid statistical bias. They are given below:

Northeast:	October	−3.2±11.7
	December	−4.2±18.1
South:	November	−0.5±2.4
Central:	October	−3.3±12.6

[d] The analytical error of the average value was calculated using the formula:

$$E(\text{avg}) = \frac{\sqrt{\Sigma(E)^2}}{n}$$

[e] Sample lost.

The recommendation of the International Commission on Radiological Protection (*8*) for the maximum permissible concentration $(MPC)_w$ of plutonium–239 in water for the general population is one-tenth the $(MPC)_w$ for the 168-week occupational exposure. This yields a $(MPC)_w$ for the general population of 5×10^{-6} μCi/cc, which in turn results in a daily intake of 1.1×10^{7} fCi/day, based on a water intake of 2.2 liters/day. Since the $(MPC)_w$'s for plutonium–239 and plutonium–240 are the same, it is not significant whether the activity observed was from only plutonium–239 or whether the activity observed included a plutonium–240 component. In comparison to this guideline, the levels of plutonium–239 observed in the total diets analyzed are seen to be extremely small—in fact, to approach the level of analytical detectability.

Using a gastrointestinal absorption factor for plutonium–239 of 3×10^{-5} as suggested by the International Commission on Radiological Protection (*8*), the calculated amount of plutonium–239 reaching the blood stream from the above diets is estimated to be 2×10^{-4} fCi/day.

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Data

Section I. Milk and Food

In the determination of the internal exposure to man from environmental radiation sources, primary interest centers on radionuclides in the diet. Efforts are being made by both Federal and State agencies to monitor the intake of various radionuclides in the total diet on a continuing basis. The total diet is the most direct measure of intake of radionuclides; however, because specific dietary data are not readily available, indicator foods may be used to estimate radionuclide intake.

Fresh milk is consumed by a large segment of the U.S. population. It contains most of the biologically significant radionuclides from nuclear test debris which appear in the diet and is the major source of dietary intake of short-lived radionuclides. For these reasons, it is the single food item most often used as an indicator of the population's intake of radionuclides. In the absence of specific information, one may assume that the total daily dietary intake of selected radionuclides is equivalent to the intake represented by the consumption of 1 liter of milk. More direct estimates of dietary intake of radionuclides than those furnished by indicator foods can be obtained by analyses of the total diet or representative principal food items or groups combined with appropriate consumption data.

The Federal Radiation Council (FRC) has developed Radiation Protection Guides (RPG's) for controlling normal peacetime nuclear operations, assuming continuous exposure from intake by the population at large (*1–3*). The RPG's do not and cannot establish a line which is safe on one side and unsafe on the other; they do provide an indication of when there is a need to initiate careful evaluation of exposure (*3*). Additional guidelines are provided by the FRC Protective Action Guides (*4*) and by the International Commission on Radiological Protection (*5,6*).

Data from selected national, international, and State milk and food surveillance activities are presented herein. An effort has been made to present a cross-section of routine sampling programs which may be considered of a continuing nature. Routine milk sampling has been defined as one or more samples collected per month.

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NATIONAL AND INTERNATIONAL MILK SURVEILLANCE

As part of continuing efforts to quantitatively monitor man's exposure to radionuclides, various national and international organizations routinely monitor radionuclide levels in milk. In addition to the programs reported below, *Radiological Health Data and Reports* coverage includes:

Program	Period reported	Last presented
Radiostrontium in milk, HASL	January-June 1966	March 1967

1. Pasteurized Milk Network December 1966

National Center for Radiological Health and National Center for Urban and Industrial Health, PHS

The Public Health Service's Pasteurized Milk Network (PMN) was designed to provide nationwide surveillance of radionuclide concentrations in milk through sampling from major milk production and consumption areas. The present network of 63 sampling stations (figure 1) provides data on milk in every State, the Canal Zone, and Puerto Rico. The most recent description of the sampling and analytical procedures employed by the PMN appeared in the December 1966 issue of *Radiological Health Data and Reports* (*1*).

The results for December 1966 and fourth quarter of 1966 are presented in table 1. The average monthly radionuclide concentrations

Figure 1. Pasteurized Milk Network sampling stations

Table 1. Average concentrations of radionuclides in pasteurized milk for the fourth quarter and December 1966

Sampling location		Strontium-89 (pCi/liter)		Strontium-90 (pCi/liter)		Iodine-131 (pCi/liter)		Cesium-137 (pCi/liter)		Barium-140 (pCi/liter)	
		Fourth quarter 1966	Dec 1966	Fourth quarter 1966	Dec 1966	Fourth quarter 1966	Dec 1966	Fourth quarter 1966	Dec 1966	Fourth quarter 1966	Dec 1966
Ala:	Montgomery	<5	<5	10	9	0	0	15	15	0	0
Alaska:	Palmer	<5	<5	14	13	0	0	25	25	0	0
Ariz:	Phoenix	<5	<5	3	2	0	0	5	<5	0	0
Ark:	Little Rock	5	5	24	23	0	0	20	20	0	0
Calif:	Sacramento	<5	<5	3	3	0	0	5	5	0	0
	San Francisco	<5	<5	3	2	0	0	10	5	0	0
C.Z.:	Cristobal	<5	<5	5	4	0	0	25	25	0	0
Colo:	Denver	<5	<5	8	5	0	0	10	10	0	0
Conn:	Hartford	<5	<5	10	10	0	0	20	25	0	0
Del:	Wilmington	<5	<5	12	13	0	0	20	25	0	0
D.C:	Washington	<5	<5	12	12	0	0	15	15	0	0
Fla:	Tampa	10	10	10	8	0	0	95	80	0	0
Ga:	Atlanta	5	5	16	15	0	0	25	25	0	0
Hawaii:	Honolulu	<5	<5	4	4	0	0	15	15	0	0
Idaho:	Idaho Falls	<5	<5	9	8	0	0	15	15	0	0
Ill:	Chicago	<5	<5	8	8	0	0	15	20	0	0
Ind:	Indianapolis	<5	<5	10	10	0	0	15	20	0	0
Iowa:	Des Moines	<5	<5	9	8	0	0	15	15	0	0
Kans:	Wichita	<5	<5	14	18	0	0	10	10	0	0
Ky:	Louisville	10	10	13	13	0	0	10	10	0	0
La:	New Orleans	<5	<5	27	25	0	0	35	30	0	0
Maine:	Portland	<5	<5	14	13	0	0	45	45	0	0
Md:	Baltimore	<5	<5	11	10	0	0	15	15	0	0
Mass:	Boston	<5	<5	13	13	0	0	35	35	0	0
Mich:	Detroit	<5	<5	10	12	0	0	15	20	0	0
	Grand Rapids	<5	<5	12	13	0	0	20	20	0	0
Minn:	Minneapolis	<5	<5	21	24	0	0	15	15	0	0
Miss:	Jackson	15	15	17	15	0	0	15	15	0	0
Mo:	Kansas City	<5	<5	11	9	0	0	10	10	0	0
	St. Louis	<5	<5	12	10	0	0	15	15	0	0
Mont:	Helena	<5	<5	12	14	0	0	20	15	0	0
Nebr:	Omaha	<5	<5	10	8	0	0	10	10	0	0
Nev:	Las Vegas	<5	<5	3	3	0	0	10	10	0	0
N.H:	Manchester	<5	<5	15	17	0	0	45	45	0	0
N.J:	Trenton	<5	<5	10	11	0	0	20	20	0	0
N. Mex:	Albuquerque	<5	<5	4	5	0	0	5	5	0	0
N.Y:	Buffalo	<5	<5	9	9	0	0	20	20	0	0
	New York	<5	<5	12	12	0	0	25	25	0	0
	Syracuse	<5	<5	9	9	0	0	20	30	0	0
N.C:	Charlotte	<5	<5	20	19	0	0	20	20	0	0
N. Dak:	Minot	<5	<5	24	21	0	0	20	20	0	0
Ohio	Cincinnati	<5	<5	10	9	0	0	15	15	0	0
	Cleveland	<5	<5	10	11	0	0	20	25	0	0
Okla:	Oklahoma City	<5	<5	9	8	0	0	10	10	0	0
Ore:	Portland	<5	<5	10	8	0	0	20	20	0	0
Penn:	Philadelphia	<5	<5	11	11	0	0	20	20	0	0
	Pittsburgh	<5	<5	14	15	0	0	20	25	0	0
P.R.:	San Juan	5	5	6	5	0	0	15	15	0	0
R.I:	Providence	<5	<5	12	11	0	0	25	25	0	0
S.C:	Charleston	<5	<5	20	19	0	0	30	30	0	0
S. Dak:	Rapid City	<5	<5	16	13	0	0	15	20	0	0
Tenn:	Chattanooga	<5	<5	18	18	0	0	20	20	0	0
	Memphis	<5	<5	14	12	0	0	10	10	0	0
Tex:	Austin	<5	<5	4	4	0	0	5	5	0	0
	Dallas	<5	<5	10	10	0	0	10	15	0	0
Utah:	Salt Lake City	<5	<5	12	16	0	0	15	15	0	0
Vt:	Burlington	<5	<5	11	11	0	0	25	25	0	0
Va:	Norfolk	10	10	14	13	0	0	15	10	0	0
Wash:	Seattle	<5	<5	16	12	0	0	35	25	0	0
	Spokane	<5	<5	14	13	0	0	25	25	0	0
W. Va:	Charleston	5	5	15	13	0	0	10	10	0	0
Wis:	Milwaukee	<5	<5	9	9	0	0	15	15	0	0
Wyo:	Laramie	<5	<5	8	10	0	0	10	10	0	0
Network average		<5	<5	11.7	11.3	0	0	20	20	0	0

Table 2. Frequency distribution, strontium-90 concentrations in milk at Pasteurized Milk Network stations, December 1965 and July–December 1966

Strontium-90 (pCi/liter)	Number of stations						
	1965	1966					
	Dec	July	Aug	Sept	Oct	Nov	Dec
Under 10	9	14	15	21	18	19	23
10–19	43	39	40	37	39	40	35
20–29	11	9	7	5	6	4	5
30–39	0	1	1	0	0	0	0

Table 3. Frequency distribution, cesium-137 concentrations in milk at Pasteurized Milk Network stations, December 1965 and July–December 1966

Cesium-137 (pCi/liter)	Number of stations						
	1965	1966					
	Dec	July	Aug	Sept	Oct	Nov	Dec
Under 50	[1]51	56	56	61	62	61	62
50–99	11	6	6	1	0	2	1
100–149	1	1	1	1	1	0	0
150–199	0	0	0	0	0	0	0

Table 4. Iodine-131 concentrations, pCi/liter, in Pasteurized

Station location		December 1966														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ala:	Montgomery	<10							<10						<10	
Alaska:	Palmer						<10							<10		
Ariz:	Phoenix	<10							<10							<10
Ark:	Little Rock					<10							<10			
Calif:	Sacramento		<10							<10						<10
	San Francisco	<10							<10							
C.Z.	Cristobal					<10							<10			
Colo:	Denver									<10						<10
Conn:	Hartford		<10							<10						
Del:	Wilmington	<10							16							<10
D.C.	Washington	<10							<10							<10
Fla:	Tampa							<10								<10
Ga:	Atlanta							<10					<10			
Hawaii:	Honolulu						<10							<10		
Idaho:	Idaho Falls					<10							<10			
Ill:	Chicago						<10							<10		
Ind:	Indianapolis					<10							<10			
Iowa:	Des Moines	<10							<10							<10
Kans:	Wichita					<10							<10			
Ky:	Louisville						<10							<10		
La:	New Orleans	<10							<10						<10	
Maine	Portland					<10							<10			
Md:	Baltimore						<10							<10		
Mass:	Boston						<10							<10		
Mich:	Detroit						<10							<10		
	Grand Rapids					<10							<10			
Minn:	Minneapolis						<10							<10		
Miss:	Jackson					<10							<10			
Mo:	Kansas City		<10							10						
	St. Louis		<10							<10						
Mont:	Helena						<10								<10	
Nebr:	Omaha	<10								<10						<10
Nev:	Las Vegas							<10								
N.H:	Manchester						<10							<10		
N.J:	Trenton						<10							<10		
N. Mex:	Albuquerque					<10							<10			
N.Y:	Buffalo		<10							<10						
	New York					<10							<10			
	Syracuse								12						<10	
N.C:	Charlotte					<10							<10			
N. Dak:	Minot					<10							<10			
Ohio:	Cincinnati					<10								<10		
	Cleveland									<10						
Okla:	Oklahoma City		12							<10						
Ore:	Portland		<10							<10						
Pa:	Philadelphia		14							<10						
	Pittsburgh						<10							<10		
P.R:	San Juan					<10							<10			
R.I:	Providence						<10							<10		
S.C:	Charleston						<10							<10		
S. Dak:	Rapid City					<10							<10			
Tenn:	Chattanooga	<10							<10							<10
	Memphis	<10							<10							<10
Tex:	Austin		18							<10						
	Dallas					<10							<10			
Utah:	Salt Lake City					<10							<10			<10
Vt:	Burlington							<10							<10	
Va:	Norfolk		<10							<10						
Wash:	Seattle	<10							<10							<10
	Spokane						<10							<10		
W. Va:	Charleston			12							<10					
Wis:	Milwaukee	<10								<10						
Wyo:	Laramie							<10							<10	

are based on results obtained from samples collected weekly. If radionuclide values were below minimum detectable concentrations (*1*), averages were calculated using one-half the minimum detectable value; however, for iodine-131 and barium-140, zero was used for averaging purposes when concentrations were below minimum detectable levels.

For comparative purposes, distributions of strontium-90 and cesium-137 are presented in

Milk Network samples, December 1966

December 1966—Continued																Station location	
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
				<10								<10				Ala:	Montgomery.
				<10					<10							Alaska:	Palmer.
							<10						<10			Ariz:	Phoenix.
			<10													Ark:	Little Rock.
<10							<10							<10		Calif:	Sacramento.
						<10							<10				San Francisco.
			<10								<10					C.Z:	Cristobal.
					11								<10			Colo:	Denver.
<10							<10							<10		Conn:	Hartford.
						<10						<10				Del:	Wilmington.
						<10								<10		D.C:	Washington.
			<10								<10					Fla:	Tampa.
					<10						<10					Ga:	Atlanta.
				<10							<10					Hawaii:	Honolulu.
			<10								<10					Idaho:	Idaho Falls.
				14							<10					Ill:	Chicago.
			<10								<10					Ind:	Indianapolis.
						<10							<10			Iowa:	Des Moines.
			<10							<10						Kans:	Wichita.
				<10							<10					Ky:	Louisville.
					<10								<10			La:	New Orleans.
			<10								11					Maine:	Portland.
				11							<10					Md:	Baltimore.
				10							<10					Mass:	Boston.
				<10							23					Mich:	Detroit.
			<10								<10						Grand Rapids.
				<10							<10					Minn:	Minneapolis.
			<10													Miss:	Jackson.
<10							<10							<10		Mo:	Kansas City.
<10							<10							<10			St. Louis.
				<10							<10					Mont:	Helena.
							<10							<10		Nebr:	Omaha.
<10				<10								<10				Nev:	Las Vegas.
				<10							<10					N.H:	Manchester.
				<10							<10					N.J:	Trenton.
			<10								<10					N. Mex:	Albuquerque.
13							<10							<10		N.Y:	Buffalo.
			10								<10						New York.
				14													Syracuse.
			<10								<10					N.C:	Charlotte.
			<10								<10					N. Dak:	Minot.
					14							<10				Ohio:	Cincinnati.
<10						13								10			Cleveland.
<10				<10									<10			Okla:	Oklahoma City.
<10							<10							<10		Ore:	Portland
<10							<10							<10		Pa:	Philadelphia.
				<10							<10						Pittsburgh.
			<10													P.R:	San Juan.
				<10							<10					R.I:	Providence.
				<10												S.C:	Charleston.
			<10								<10					S. Dak:	Rapid City.
				<10		<10							<10			Tenn:	Chattanooga.
												<10					Memphis.
<10						<10										Tex:	Austin.
			<10														Dallas.
				<10						<10						Utah:	Salt Lake City.
					<10											Vt:	Burlington.
<10							<10							<10		Va:	Norfolk.
						<10							<10			Wash:	Seattle.
				<10							<10						Spokane.
	<10														<10	W. Va:	Charleston.
<10					<10							14				Wis:	Milwaukee.
					<10							<10				Wyo:	Laramie.

tables 2 and 3 for December 1965 and July through December 1966. The average strontium-90 concentrations in pasteurized milk from selected cities are presented in figure 2. Individual iodine-131 milk concentrations for December 1966 are shown in table 4. Concentrations greater than the minimum detectable level of 10 pCi/liter are presumed to reflect the fourth Chinese atmospheric nuclear test of October 27, 1966, EST.

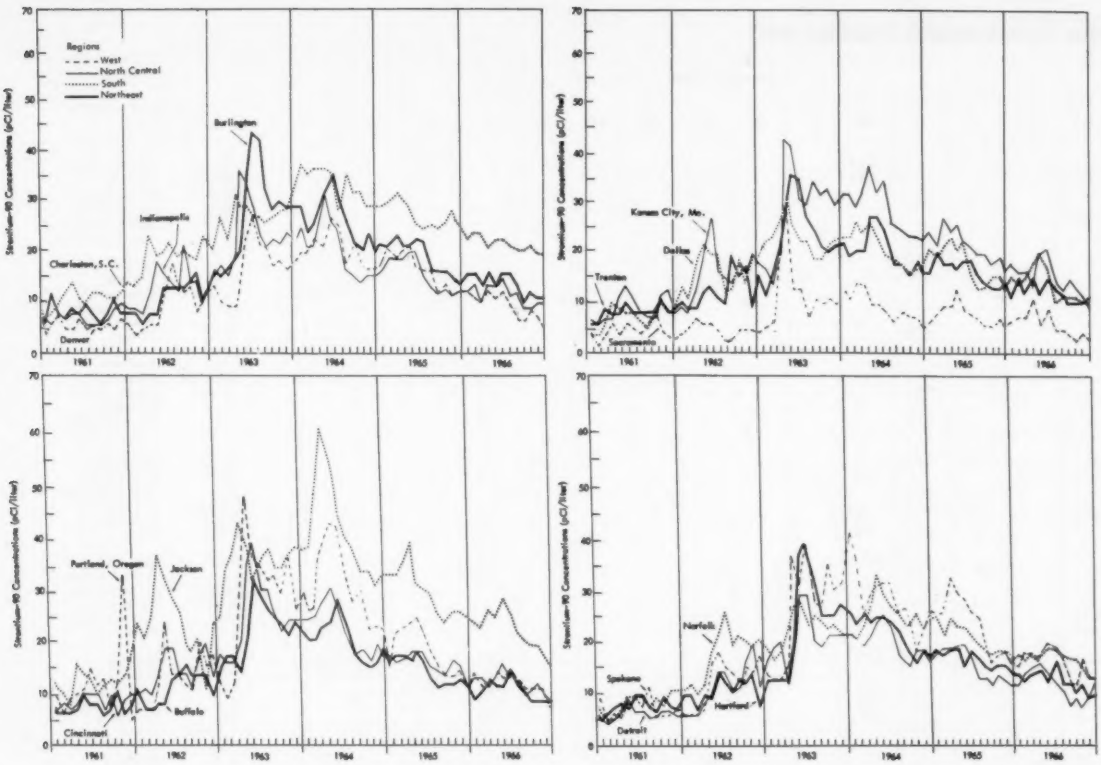

Figure 2. Strontium–90 concentrations in pasteurized milk, 1961–December 1966

2. Canadian Milk Network December 1966[1]

Radiation Protection Division
Department of National Health and Welfare

Since November 1955, the Radiation Protection Division of the Department of National Health and Welfare has been monitoring milk for radionuclide concentrations. Powdered milk was originally sampled, but liquid whole milk has been sampled since January 1963. At present, 16 milk sampling stations (figure 3) are in operation. Their locations coincide with air and precipitation sampling stations.

Milk samples are collected three times a

Table 5. Stable elements and radionuclides in Canadian wholemilk, December 1966

Station	Calcium (g/liter)	Potassium (g/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Calgary	1.18	1.5	15.5	29
Edmonton	1.11	1.6	12.5	34
Ft. William	1.09	1.6	17.0	37
Fredericton	1.11	1.6	19.0	42
Halifax	1.10	1.5	16.1	41
Montreal	1.10	1.5	12.3	26
Ottawa	1.16	1.6	9.7	22
Quebec	1.11	1.6	18.8	48
Regina	1.14	1.6	13.4	26
St. John's, Nfld	1.13	1.6	19.2	48
Saskatoon	1.16	1.6	14.5	27
Sault Ste. Marie	1.13	1.6	13.0	37
Toronto	1.14	1.6	7.1	18
Vancouver	1.20	1.5	20.2	78
Windsor	1.15	1.6	6.8	17
Winnipeg	1.12	1.6	10.4	28
Average	1.13	1.6	14.1	35

[1] Prepared from January 1967 monthly reports "Data from Radiation Protection Programs," Canadian Department of National Health and Welfare, Ottawa, Canada.

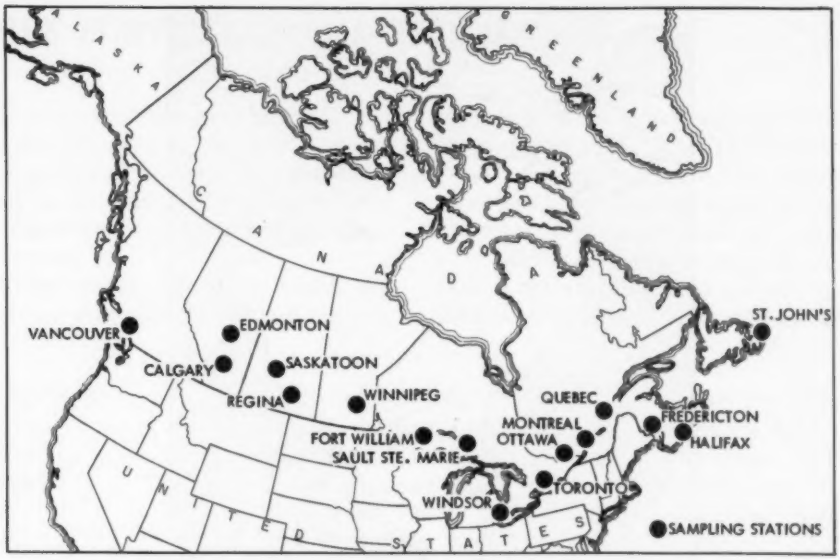

Figure 3. Canadian milk sampling stations

week from selected dairies and are combined into weekly composites. The contribution of each dairy to the composite sample is directly proportional to the liquid volume of sales. Weekly spot check analyses are made for iodine-131, and monthly composites are analyzed for strontium-90, cesium-137, and stable calcium and potassium. The analytical procedures were outlined in the December 1966 issue of *Radiological Health Data and Reports* (*2*).

The December 1966 monthly average strontium-90, cesium-137, and stable calcium and potassium concentrations in Canadian whole milk are presented in table 5. Iodine-131 and strontium-89 concentrations were below minimum detectable levels.

3. Pan American Milk Sampling Program December 1966

Pan American Health Organization and U.S. Public Health Service

The Pan American Health Organization (PAHO), in collaboration with the U.S. Public Health Service (PHS), furnishes assistance to health agencies in the American republics in developing national radiological health programs.

Under a joint agreement between the agencies, air and milk sampling activities are conducted by a number of PAHO member countries (figure 4). Results of the milk sampling program are presented below. Further information on the sampling and analytical procedures employed was presented in the December 1966 issue of *Radiological Health Data and Reports* (*3*).

Table 6 presents stable potassium, strontium–89, strontium-90, and cesium-137 monthly average concentrations for December 1966.

Figure 4. Pan American Milk Sampling Program locations

Table 6. Stable element and radionuclide concentrations in PAHO milk, December 1966 [a]

Sampling stations		Number of Samples	Potassium (g/liter)	Strontium-89 [b] (pCi/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Chile:	Santiago	4	1.52	5	2	7
Colombia:	Bogota	1	1.49	5	4	10
Ecuador:	Guayaquil	NS				
Jamaica:	Kingston	NS				
	Mandeville	NS				
	Montego Bay	1	1.43	10	10	320
Venezuela:	Caracas	NS				
Canal Zone:	Cristobal [c]	4	NA	<5	4	25
Puerto Rico:	San Juan [c]	4	NA	5	5	15

[a] Iodine-131 and barium-140 were below the detectable limits of 10 pCi/liter.
[b] Data have been corrected for decay to the date of sample collection.
[c] For comparison purposes, the radionuclide concentrations at Cristobal, Canal Zone; and San Juan, Puerto Rico, are presented.
NS, no sample collected.
NA, no analysis performed.

REFERENCES

(*1*) PUBLIC HEALTH SERVICE. Pasteurized Milk Network, August 1966. Radiol Health Data Rep 7:698–701 (December 1966).

(*2*) DEPARTMENT OF NATIONAL HEALTH AND WELFARE, RADIATION PROTECTION DIVISION. Canadian Milk Network, August 1966. Radiol Health Data Rep 7:702–703 (December 1966).

(*3*) PAN AMERICAN HEALTH ORGANIZATION and U.S. PUBLIC HEALTH SERVICE. Pan American Milk Sampling Program, August 1966. Radiol Health Data Rep 7:704–705 (December 1966).

STATE MILK SURVEILLANCE ACTIVITIES

Considerable progress has been made by the State health departments in initiating or expanding environmental surveillance activities in radiological health. Many of the States have developed comprehensive environmental surveillance programs.

The continuing efforts of State health departments in the analysis and monitoring of radionuclides in milk complement Federal milk surveillance activities. The results presented herein are representative of current surveillance activities directed at the use of milk as an indicator of dietary intake of radioactivity.

In addition to the State milk networks presented herein, programs previously covered in *Radiological Health Data and Reports* include:

State milk network	Period reported	Last presented
California	July-September 1966	March 1967
Colorado	May 1965-June 1966	October 1966
Connecticut	July-September 1966	February 1967
Florida	April-June 1966	October 1966
Indiana	July-September 1966	February 1967
Michigan	July-September 1966	February 1967
Minnesota	July-September 1966	February 1967
Oregon	July-September 1966	March 1967
New York	January-June 1966	February 1967
Pennsylvania	July-September 1966	February 1967
Washington	July-September 1966	March 1967

1. Oklahoma Milk Network October-December 1966

Oklahoma State Department of Health[1]

In March 1965, the Radiological Health Section of the Oklahoma State Department of Health initiated a program of analysis for iodine-131 in the milk produced in the State of Oklahoma. In March 1966, analysis for cesium-137 was added to the program.

The location of the sampling stations and the extent of their associated milksheds are shown in figure 1. Of the 10 milksheds in the State of Oklahoma, 5 were chosen as sampling stations (Oklahoma City, Enid, Tulsa, Lawton, and Ardmore) on the basis of their size and location. A major criterion in the selection of a milkshed for sampling was the degree of overlap with other milksheds being sampled. This overlap assists in locating small areas of production where the iodine-131 concentrations might be abnormally high.

The sampling stations are located in the laboratory of a major milk processing plant in each milkshed. While the milkshed for a particular processing plant may not coincide exactly with that shown in figure 1, the coincidence is satisfactory for surveillance purposes.

At the present time, samples are collected on Monday morning, and the analyses are completed by Wednesday afternoon. However, if iodine-131 levels detected are such that diversion of the milk or other precautionary methods need to be taken, the analytical method and equipment can be employed to sample each truck arriving at the processing plan. Under these conditions, about 4 hours would be needed to complete the analysis. This reduced lag time

[1] Acknowledgement is accorded to the staff of the Radiological Health Section under the direction of Mr. Dale McHard, head, and Mr. Robert Craig, assistant engineer.

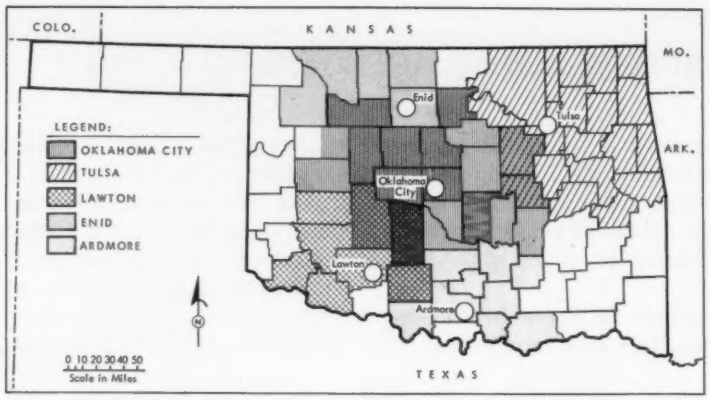

Figure 1. Oklahoma milkshed sampling areas

for analysis would permit rapid decisions on the fate of each truckload of raw milk.

Analytical method

The method of analysis is similar to that published by the U.S. Public Health Service (*1*) but was developed independently by the Oklahoma State Health Department's Radiological Health Laboratory.

The sampling stations are supplied with plastic cartridges containing 10 ml of Dowex 1X8 (50- to 100-mesh anion exchange resin). On the sampling date, 1 gallon of pasteurized whole milk is passed through the cartridge, the residual milk is washed from the resin with distilled water, and the cartridge is mailed to the Radiological Health Laboratory. The sample is analyzed for 100 minutes in a 2- by 2-inch well type, thallium-activated sodium iodide crystal, in conjunction with a 400-channel analyzer. The results are corrected to noon of the sampling date. The minimum detectable iodine-131 concentration in milk is 0.9 pCi/liter (3 standard deviations of background).

Results and discussion

Table 1 gives the concentrations of iodine-131 found in Oklahoma milk samples collected from October through December 1966. Cesium-137 concentrations are presented in table 2.

Recent coverage in *Radiological Health Data and Reports*:

Period	Issue
January–March 1966	July 1966
April–June 1966	October 1966
July–September 1966	January 1967

Table 1. Concentration of iodine-131 in Oklahoma milk, October–December 1966

Sampling date	Sampling location (concentration, pCi/liter)				
	Oklahoma City	Enid	Tulsa	Lawton	Ardmore
October 3	NS	NS	NS	NS	0
10	0	0	0	NS	NS
17	NS	NS	NS	0	0
24	0	0	0	NS	NS
31	NS	NS	NS	0	0
November 7	8	12	0	NS	NS
14	19	5	28	NS	11
21	0	0	0	NS	NS
28	NS	NS	NS	0	0
December 5	0	NS	0	0	NS
12	NS	7	NS	0	NS
19	0	NS	0	NS	0
26	IF	IF	IF	IF	IF

NS, no sample collected.
IF, instrument failure.

Table 2. Concentration of cesium-137 in Oklahoma milk, October–December 1966

Sampling date	Sampling location (concentration, pCi/liter)				
	Oklahoma City	Enid	Tulsa	Lawton	Ardmore
October 3	NS	NS	NS	NS	4
10	16	NS	14	NS	NS
17	NS	NS	NS	11	8
24	13	13	7	NS	NS
31	NS	NS	NS	22	8
November 7	21	38	18	NS	NS
14	26	23	31	NS	27
21	13	6	19	NS	NS
28	NS	NS	NS	IF	0
December 5	4	NS	9	21	NS
12	NS	46	NS	1	NS
19	14	NS	24	NS	19
26	IF	IF	IF	IF	IF

NS, no sample collected.
IF, instrument failure.

2. Tennessee Milk Network July 1965-June 1966

Division of Preventable Diseases
Department of Public Health
State of Tennessee

The Tennessee Department of Public Health began sampling pasteurized milk for radionuclide analysis in July of 1965. Currently the Department is collecting milk samples every two weeks from three cities (figure 2). In order to obtain a representative sample of the milk consumed in the areas monitored, milk is collected from each distributor supplying the city. The samples from the individual distributors are then composited in proportion to the contribution each makes to the total city milk supply.

Analytical procedures

The biweekly milk samples from each of the three cities are analyzed by gamma-ray scintillation spectrometry for potassium-40, iodine-131, cesium-137, and barium-140, using a 3.5 liter sample (*2*). After gamma-ray analysis, the samples are stored for 2 weeks to allow ingrowth of daughter activity, after which stron-

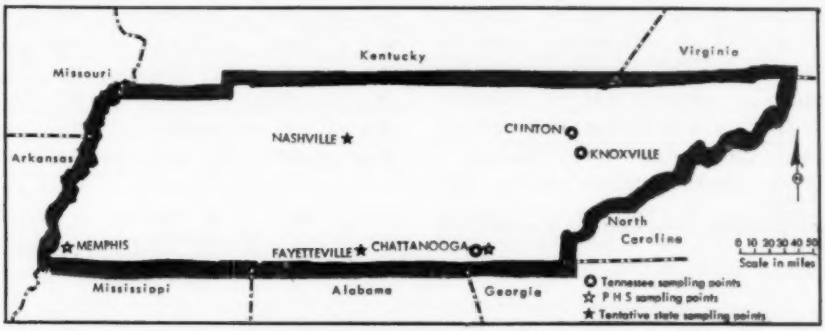

Figure 2. Tennessee pasteurized milk network sampling stations

Table 3. Radionuclides in Chattanooga, Tennessee, pasteurized milk, July 1965–June 1966

Date	Concentration (pCi/liter)			Radionuclide concentration (pCi/liter)					
	Calcium	Potassium		Strontium-89	Strontium-90	Iodine-131	Cesium-137	Barium-140	
		A [a]	B [b]					A [a]	B [b]
1965									
July	1.18	1.71	NA	6	33	NA	56	[c]<5	8
August	1.20	1.75	NA	<5	27	NA	53	<5	<5
September	1.18	1.72	NA	<5	31	NA	47	<5	<5
October	1.20	1.67	NA	<5	25	NA	41	<5	6
November	1.21	1.51	NA	10	22	NA	48	<5	<5
December	1.12	1.57	1.73	<5	24	NA	42	<5	6
1966									
January	1.12	1.57	1.55	<5	24	<8	35	<5	8
February	1.15	1.52	1.49	<5	25	<8	39	<5	<5
March	1.21	1.47	1.52	<5	24	<8	43	<5	6
April	1.20	1.52	1.47	5	26	<8	41	<5	<6
May	1.23	1.47	1.51	6	23	<8	40	<5	5
June	1.20	1.56	1.51	30	23	14	39	<5	6

[a] A, gamma-ray analysis.
[b] B, chemical analysis.
[c] "Less than" sign (<) indicates values were below detectable limits.
NA, no analysis.

Table 4. Radionuclides in Clinton, Tennessee, pasteurized milk, July 1965–June 1966

Date	Concentration (pCi/liter)			Radionuclide concentration (pCi/liter)					
	Calcium	Potassium		Strontium-89	Strontium-90	Iodine-131	Cesium-137	Barium-140	
		A [a]	B [b]					A [a]	B [b]
1965									
July	1.19	1.75	NA	6	32	14	62	[c] <5	5
August	1.18	1.70	NA	<5	29	<8	49	<5	<5
September	1.18	1.65	NA	<5	31	9	49	<5	<5
October	1.21	1.70	NA	<5	26	14	47	<5	9
November	1.19	1.70	NA	6	25	18	45	<5	<5
December	1.12	1.70	1.75	<5	25	20	52	<5	<5
1966									
January	1.12	1.51	1.67	<5	22	4	43	<5	9
February	1.16	NA	1.52	<5	22	NA	NA	NA	<5
March	1.21	1.51	1.55	<5	23	<8	56	<5	<5
April	1.20	1.51	1.48	7	23	<8	47	<5	<5
May	1.23	1.52	1.54	<5	28	<8	44	<5	<5
June	1.17	1.54	1.51	46	24	13	42	<5	8

[a] A, gamma-ray analysis.
[b] B, chemical analysis.
[c] "Less than" sign (<) indicates values were below detectable limits.
NA, no analysis.

Table 5. Radionuclides in Knoxville, Tennessee, pasteurized milk, July 1965–June 1966

Date	Concentrtion (pCi/liter)			Radionuclide concentration (pCi/liter)					
	Calcium	Potassium		Strontium-89	Strontium-90	Iodine-131	Cesium-137	Barium-140	
		A [a]	B [b]					A [a]	B [b]
1965									
July	1.16	1.69	NA	11	24	19	57	[c] <5	<5
August	1.15	1.70	NA	<5	23	<8	42	<5	<5
September	1.15	1.74	NA	<5	21	9	39	<5	<5
October	1.19	1.71	NA	<5	20	11	43	5	<5
November	1.18	1.76	NA	<5	17	22	42	7	<5
December	1.13	1.61	1.77	<5	18	13	41	<5	<5
1966									
January	1.10	1.50	1.62	<5	19	<8	40	<5	<5
February	1.13	1.54	1.51	<5	18	<8	42	<5	<5
March	1.14	1.53	1.53	5	18	<8	45	<5	<5
April	1.17	1.48	1.48	<5	21	<8	45	<5	<5
May	1.15	1.60	1.53	7	23	<8	44	<5	<5
June	1.15	1.53	1.49	12	19	10	42	<5	7

[a] A, gamma-ray analysis.
[b] B, chemical analysis.
[c] "Less than" sign (<) indicates values were below detectable limits.
NA, no analysis.

tium-89, strontium-90, and barium-140 concentrations are determined radiochemically using ion exchange procedures. Chemical analyses are also made for stable calcium and potassium.

The Chattanooga milk sample is monitored by both the State and the Public Health Service's Southeastern Radiological Health Laboratory. This dual examination of aliquot samples provides a cross check between the two laboratories.

Results

The monthly averages of stable element and radionuclide concentrations in Tennessee pasteurized milk are presented in tables 3 to 5 for the period of July 1965 through June 1966.

3. Texas Milk Network October-December 1966

Texas State Department of Health[2]

The Texas State Department of Health initiated a statewide milk sampling network for radionuclide content in April 1964. At present, monthly samples of raw milk are collected from each of seven "active" sampling points. In addition, six "standby" stations are collecting raw milk samples once each calendar quarter. The station locations shown in figure 4 were chosen to give maximum geographical and population coverage.

Samples are routinely analyzed for strontium-89 strontium-90 concentrations by a chemical separation technique employing ion exchange columns (*3*). Prepared samples are counted for 100 minutes in a low-background beta-particle counter.

Potassium-40, iodine-131, cesium-137, and barium-140 concentrations are determined by gamma-ray scintillation spectrometry. The procedure employs a 4- by 4-inch sodium iodide crystal and a 400-channel analyzer. Samples

[2] Acknowledgment is accorded to the staff of the Radiation Control Program, Division of Occupational Health and Radiation Control, under the direction of Mr. Martin C. Wukasch, chief engineer.

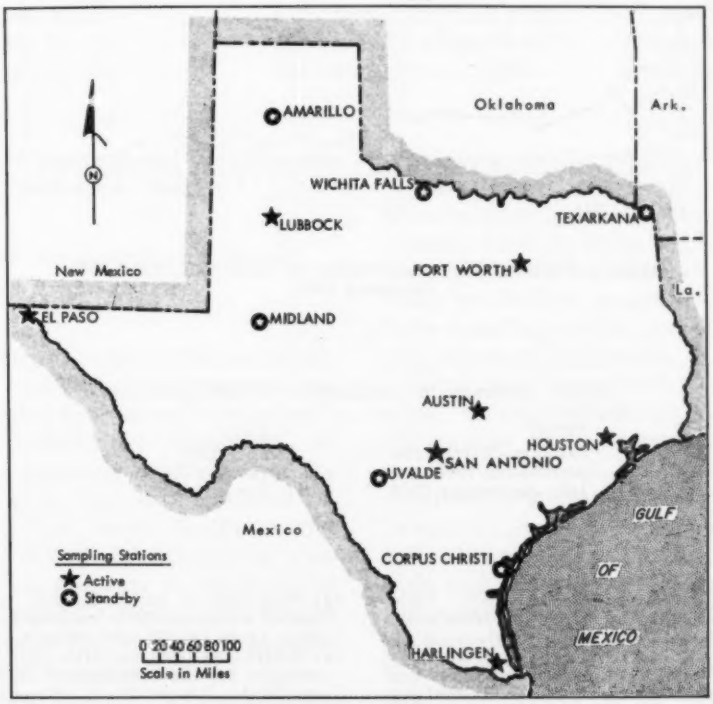

Figure 3. Texas milk sampling stations

are counted for 100 minutes in a 3.5-liter Marinelli beaker. The matrix method of calculation is used and detection limits at the 95-percent confidence level are 10 pCi/liter.

Results

Potassium-40, strontium-90, iodine-131, and cesium-137 results by station and month for October through December 1966 are presented in table 6. During this time, the strontium-89 concentration was below the limit of detectability (5 pCi/liter). A summary of radionuclide concentrations in Texas milk for the period April 1964 to December 1966 is presented in figure 4.

Comparison of the observed radionuclide concentrations with the Federal Radiation Council guides for peacetime operation indicates that at no time during the period of surveillance did the radionuclide concentrations in Texas milk approach levels suggesting any remedial action (*4*).

Table 6. Radionuclide concentrations in Texas milk, network October–December 1966

Sampling location	Potassium-40 (pCi/liter)			Strontium-90 (pCi/liter)		
	Oct	Nov	Dec	Oct	Nov	Dec
Austin	1,300	1,350	1,360	5	5	4
Fort Worth	NS	1,320	1,390	NS	8	8
El Paso	1,230	1,310	1,230	4	4	4
Harlingen	1,350	1,400	1,360	3	6	3
Houston	1,330	1,210	1,420	15	12	11
Lubbock	1,320	1,310	1,300	4	8	5
San Antonio	1,240	1,380	1,270	5	5	5
Average	1,300	1,300	1,330	6	7	6

	Iodine-131 (pCi/liter)			Cesium-137 (pCi/liter)		
	Oct	Nov	Dec	Oct	Nov	Dec
Austin	ND	20	<10	10	10	10
Fort Worth	NS	10	ND	NS	5	5
El Paso	ND	<10	ND	10	10	10
Harlingen	<10	20	<10	10	5	10
Houston	ND	30	<10	20	20	20
Lubbock	ND	<10	ND	10	5	10
San Antonio	<10	10	ND	5	10	10
Average	<10	15	<10	11	9	11

NS, no sample.
ND, non detectable.

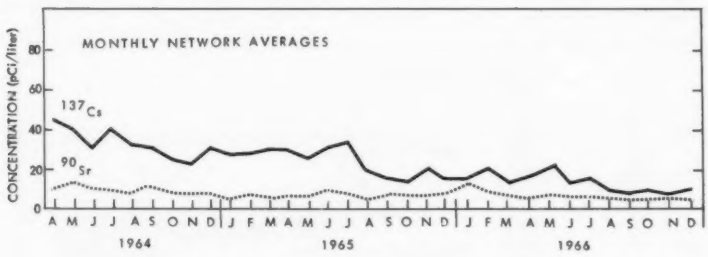

Figure 4. Radionuclide concentrations in Texas milk, April 1964–December 1966

Recent coverage in *Radiological Health Data and Reports*:

Period	Issue
January–March 1966	July 1966
April–June 1966	October 1966
July–September 1966	January 1967

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FOOD AND DIET SURVEILLANCE ACTIVITIES

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuous basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include: (1) the Public Health Service's Institutional Total Diet Sampling Network, (2) the Atomic Energy Commission's Tri-City Diet Study, (3) the Food and Drug Administration's Teenage Diet Study, (4) the State of California's Diet Study, and (5) the State of Connecticut's Standard Diet Study. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Periodically, results from the United Kingdom Diet Survey, conducted by the United Kingdom Agricultural Research Council Radiological Laboratory, are presented for comparison with data observed in the United States. Programs most recently reported in *Radiological Health Data and Reports* and not covered in this issue are listed below:

Program	Period reported	Last presented
California Diet	January-April 1966	January 1967
Connecticut Standard Diet	July 1965-June 1966	November 1966
Teenage Diet, FDA	February-November 1965	August 1966
Tri-City Diet, HASL	1965 Results (Cesium-137)	March 1967
United Kingdom Diet	Annual summary 1965	December 1966

1. Radionuclides in Institutional Diet Samples July-September 1966

National Center for Radiological Health
Public Health Service

The determination of radionuclide concentrations in the diet constitutes an important element of an integrated program of environmental radiation surveillance and assessment. In recognition of the potential significance of the diet in contributing to total environmental radiation exposures, the Public Health Service initiated its Institutional Diet Sampling Program in 1961. This program is administered by the National Center for Radiological Health with the assistance of the National Center for Urban and Industrial Health (*1*).

The program was designed to estimate the dietary intake of radionuclides in a selected population group ranging from children to young adults of school age. Initially, the program was conducted at eight institutions; as of January 1965, its scope had increased to boarding schools or institutions in 50 municipalities. These institutions ranged from financially well-to-do boarding schools to orphanages with severe economic limitations.

Subsequent experience with the diets of school children of various ages indicated that the number of institutions sampled could be selectively reduced. As of July 1965, 21 institutions, distributed geographically as shown in figure 1, were being sampled. Previous results showed that the daily intakes of teenage girls and children from 9 to 12 years of age was comparable, while teenage boys consumed 20 percent more food per day (*1,2*). Consequently, estimates for teenage boys and/or girls can be calculated on the basis of the dietary intakes of children.

In general, the sampling procedure is the same at each institution. Each sample supplied monthly by each institution represents the edible portion of the diet for a full 7-day week (21 meals plus soft drinks, candy bars, or other in-between snacks), obtained by duplicating the meals of a different individual each day. Drinking water, not included in the samples, is also sampled periodically. Each daily sample is kept frozen until the end of the collection period, and is then packed in dry ice and shipped by air express to either the Southwestern Radiological Health Laboratory, Las Vegas, Nev.; the Southeastern Radiological Health Laboratory, Montgomery, Ala.; or the Northeastern Radiological Health Laboratory; Winchester, Mass.

Table 1. Stable element and radionuclide concentrations in institutional total diets of children (9–12 years of age)[a], July–September 1966

Location of institution	Month 1966	Stable element (g/kg of diet)		Radionuclide concentration (pCi/kg of diet)			
		Calcium	Potassium	Strontium-89	Strontium-90	Cesium-137	Radium-226
Alaska: Palmer	July	0.8	1.3	<5	15	45	0.4
	Aug	.6	1.4	<5	12	35	1.7
	Sept	.6	1.2	<5	15	35	1.6
Ariz: Phoenix	July	.6	1.2	<5	10	10	1.8
	Aug	.5	1.4	<5	4	20	1.0
	Sept	.8	1.2	<5	6	5	.7
Ark: Little Rock	July	.5	1.6	<5	18	20	1.1
	Aug	.5	1.3	<5	15	15	1.4
	Sept	.4	1.3	NA	18	20	1.0
Calif: Los Angeles	July	.7	1.2	<5	6	25	.9
	Aug	1.0	1.5	<5	6	20	2.4
	Sept	.8	1.2	<5	11	25	1.6
Colo: Denver	July	.6	1.2	<5	8	20	.6
	Aug	.7	1.4	<5	8	25	.8
	Sept	.7	1.2	<5	11	20	.6
Del: Wilmington	July	NS	NS	NS	NS	NS	NS
	Aug	.7	1.6	<5	10	25	.7
	Sept	.7	1.7	<5	10	25	.5
Fla: Tampa	July	.5	1.5	<5	8	55	1.1
	Aug	.6	1.6	<5	12	75	1.8
	Sept	.6	1.7	NA	14	80	2.1
Hawaii: Honolulu	July	.5	1.3	<5	3	35	.5
	Aug	.4	1.3	<5	3	30	1.3
	Sept	.6	1.2	<5	3	25	.6
Idaho: Idaho Falls	July	1.3	1.5	<5	6	25	.5
	Aug	.8	1.4	<5	9	35	.8
	Sept	.8	1.8	<5	9	30	.5
Ill: Chicago	July	.7	1.4	5	6	20	.5
	Aug	.7	1.5	<5	6	15	.5
	Sept	.7	1.5	<5	6	20	.5
Ky: Louisville	July	NS	NS	NS	NS	NS	NS
	Aug	NS	NS	NS	NS	NS	NS
	Sept	.7	1.7	NA	13	15	1.1
La: New Orleans	July	.8	1.5	<5	16	35	.7
	Aug	.8	1.5	<5	18	35	1.1
	Sept	.7	1.7	<5	16	35	1.0
Mass: Boston	July	.6	1.6	<5	9	30	.3
	Aug	NS	NS	NS	NS	NS	NS
	Sept	.6	1.5	<5	8	25	.1
Mo: St. Louis[b]	July						
	Aug						
	Sept						
Ohio: Cleveland	July	.7	1.6	<5	7	30	.8
	Aug	.7	1.5	<5	7	20	.3
	Sept	.6	1.6	<5	9	30	.7
Pa: Pittsburgh	July	.5	1.6	<5	12	20	.6
	Aug	.6	1.4	<5	9	20	.4
	Sept	.5	1.4	<5	9	15	.8
S.C: Charleston	July	.6	1.3	<5	12	35	1.3
	Aug	.6	1.4	<5	14	30	1.1
	Sept	.7	1.3	<5	14	40	1.1
S. Dak: Sioux Falls	July	.9	1.5	5	13	35	.7
	Aug	NS	NS	NS	NS	NS	NS
	Sept	NS	NS	NS	NS	NS	NS
Tex: Austin	July	.5	1.1	<5	7	15	.9
	Aug	.6	1.2	<5	8	15	1.3
	Sept	.4	1.1	NA	7	10	.9
Vt: Burlington	July	.7	1.8	<5	15	45	.4
	Aug	.6	1.3	<5	7	40	.6
	Sept	.5	1.4	<5	9	30	.4
Wash: Seattle	July	.8	1.5	<5	15	40	.2
	Aug	NS	NS	NS	NS	NS	NS
	Sept	.8	1.5	<5	15	40	1.1
Institutional average	July	0.7	1.4	<5	10	30	0.7
	Aug	0.6	1.4	<5	9	30	1.1
	Sept	0.6	1.4	<5	11	30	0.9

[a] Iodine-131 and barium-140 concentrations were below detectable levels for this period.
[b] Institution in St. Louis, Mo., discontinued collecting samples as of July 1, 1966. New school will enter the network in November 1966.
NA, no analysis.
NS, no sample.

A detailed description of sampling and analytical procedures was presented previously (*3*).

Results

Table 1 presents the analytical results for for institutional diet samples collected from July through September 1966, for children 9 to 12 years of age. The stable elements, calcium and potassium, are reported in g/kg of diet, and the radionuclide concentrations of strontium-89, strontium-90, cesium-137, and radium-226 are expressed as pCi/kg of diet. The reported radionuclide concentrations of these samples are corrected for radioactive decay to the midpoint

Table 2. Intake of stable elements and radionuclides in institutional total diet for children (9–12 years of age), July–September 1966

Location of institution	Month 1966	Total weight (kg/day)	Stable element intake (g/day)		Radionuclide intake (pCi/day)			
			Calcium	Potassium	Strontium-89	Strontium-90	Cesium-137	Radium-226
Alaska: Palmer	July [a]	1.60	1.3	2.1	5	24	70	0.6
	Aug	1.60	1.0	2.2	5	19	55	2.7
	Sept	1.67	1.0	2.0	5	25	60	2.7
Ariz: Phoenix	July	1.99	1.2	2.4	5	20	20	3.6
	Aug	1.64	.8	2.3	5	7	35	1.6
	Sept	1.49	1.2	1.8	5	9	5	1.0
Ark: Little Rock	July	2.08	1.0	3.3	5	37	40	2.3
	Aug	2.07	1.0	2.7	5	30	30	2.9
	Sept	1.17	.5	1.5	NA	21	25	1.2
Calif: Los Angeles	July	1.75	1.2	2.1	5	10	45	1.6
	Aug	2.06	2.1	3.1	5	12	40	4.9
	Sept [b]	1.91	1.5	2.3	5	21	50	3.1
Colo: Denver	July	2.10	1.3	2.5	5	17	40	1.3
	Aug	2.00	1.4	2.8	5	16	50	1.6
	Sept	2.04	1.4	2.4	5	22	40	1.2
Del: Wilmington	July	NS	NS	NS	NS	NS	NS	NS
	Aug	2.05	1.4	3.3	5	20	50	1.4
	Sept	2.03	1.4	3.5	5	20	50	1.0
Fla: Tampa	July [b]	1.76	.9	2.6	5	14	95	1.9
	Aug [b]	2.25	1.4	3.6	5	27	170	4.0
	Sept	2.10	1.3	3.6	NA	29	170	4.4
Hawaii: Honolulu	July [b]	1.96	1.0	2.5	5	6	70	1.0
	Aug [b]	2.10	.8	2.7	5	6	65	2.7
	Sept	2.08	1.7	2.5	5	6	50	1.2
Idaho: Idaho Falls	July [b]	1.69	2.2	2.5	5	10	40	.8
	Aug [b]	2.29	1.8	3.2	5	21	80	1.8
	Sept [b]	2.33	1.9	4.2	5	21	70	1.2
Ill: Chicago	July	1.43	1.0	2.0	5	9	30	.7
	Aug	1.36	1.0	2.0	5	8	20	.7
	Sept [b]	1.75	1.2	2.6	5	10	35	.9
Ky: Louisville	July	NS	NS	NS	NS	NS	NS	NS
	Aug	NS	NS	NS	NS	NS	NS	NS
	Sept [b]	1.78	1.2	3.0	NA	23	25	2.0
La: New Orleans	July	2.06	1.6	3.1	5	33	70	1.4
	Aug	1.59	1.3	2.4	5	29	55	1.7
	Sept	1.33	.9	2.3	5	21	45	1.3
Mass: Boston	July	1.92	1.2	3.1	5	17	60	.6
	Aug	NS	NS	NS	NS	NS	NS	NS
	Sept	1.64	1.0	2.5	5	13	40	.2
Mo: St. Louis [c]	July							
	Aug							
	Sept							
Ohio: Cleveland	July	1.23	.9	2.0	5	9	35	1.0
	Aug	1.52	1.1	2.3	5	11	30	.5
	Sept	1.16	.7	1.9	5	10	35	.8
Pa: Pittsburgh	July	2.33	1.2	3.7	5	28	45	1.4
	Aug	2.23	1.3	3.1	5	20	45	.9
	Sept	2.25	1.1	3.2	5	20	35	1.8
S.C: Charleston	July	1.43	.9	1.9	5	17	50	1.9
	Aug [b]	1.62	1.0	2.3	5	23	50	1.8
	Sept	1.47	1.0	1.9	5	21	60	1.6
S. Dak: Sioux Falls	July	1.79	1.6	2.7	10	23	65	1.3
	Aug	NS	NS	NS	NS	NS	NS	NS
	Sept	NS	NS	NS	NS	NS	NS	NS
Tex: Austin	July	1.88	.9	2.1	5	13	30	1.7
	Aug	1.50	.9	1.8	5	12	20	2.0
	Sept	2.08	.8	2.3	NA	15	20	1.9
Vt: Burlington	July	1.33	.9	2.4	5	20	60	.5
	Aug	1.17	.7	1.5	5	8	45	.7
	Sept	1.24	.6	1.7	5	11	35	.5
Wash: Seattle	July	1.68	1.3	2.5	5	25	65	.3
	Aug	NS	NS	NS	NS	NS	NS	NS
	Sept [b]	1.72	1.4	2.6	5	26	70	1.9
Institutional average	July	1.79	1.1	2.6	5	19	45	1.5
	Aug	1.75	1.2	2.5	5	15	40	1.8
	Sept	1.70	1.0	2.4	5	17	50	1.5

[a] Data for this month were not used in the average because food samples were collected from two or more children under nine years of age.
[b] Data for this month were not used in average because food samples were collected from two or more children who were over 12 years of age.
[c] Institution in St. Louis, Mo., discontinued collecting samples as of July 1, 1966. New school will enter the network in November 1966.
NA, no analysis.
NS, no sample.

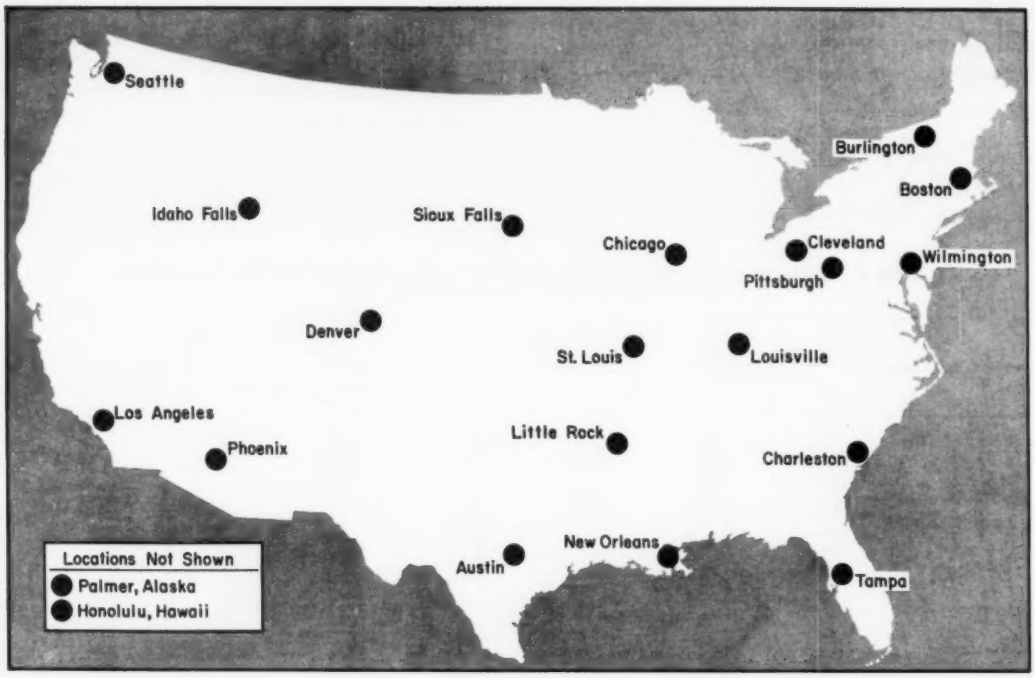

Figure 1. Current institutional diet sampling locations

of the sample collection period, where applicable.

Dietary intakes, presented in table 2, were obtained by multiplying the food consumption rate in kg/day by the concentration values given in table 1. For the purpose of obtaining dietary intakes, "less than" 5 pCi/kg of strontium-89 was interpreted as 2.5 pCi/kg. The average food consumption rate during this period was 1.75 kg/day compared to the network average of 1.90 kg/day observed from 1961 through 1964 (*4*).

Strontium-90 dietary intake during this period averaged 17 pCi/day. This result falls within Range I as defined by the Federal Radiation Council (*5*). Cesium-137 intakes average 45 pCi/day during this period. Strontium-89, iodine-131, and barium-140 concentrations were generally below detectable levels.

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Recent coverage in *Radiological Health Data and Reports*:

Period	Issue
1965 annual averages	July 1966
January–March 1966	October 1966
April–June 1966	January 1967

Section II. Water

The Public Health Service, the Federal Water Pollution Control Administration, and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These Standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*), set the limits for approval of a drinking water supply containing radium-226 and strontium-90 as 3 pCi/liter and 10 pCi/liter, respectively. Limits may be higher if total intake of radioactivity from all sources indicates that such intakes are within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when more complete analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water programs previously reported in *Radiological Health Data and Reports* are listed below.

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium–90, respectively.

Program	Period reported	Last presented
California Water Sampling Program	July-December 1965	November 1966
Coast Guard Water Sampling Program	1965	November 1966
Colorado River Basin Sampling Network	1962-1964	November 1965
Drinking Water Analysis Program	1962	October 1965
Florida Water Sampling Program	1964	November 1966
Kentucky Water Sampling Program	May 1963-June 1964	March 1965
Lower Columbia River Radiological Survey in Oregon	August 1963-July 1964	October 1965
Minnesota Surface Water Sampling Program	July-December 1965	July 1966
New York Surface Water Sampling Program	June-December 1965	June 1966
North Carolina Water Sampling Program	1964	November 1965
Radiostrontium in Tap Water, HASL	November 1965-June 1966	December 1966
Washington Surface Water Sampling Program	July 1964-June 1965	May 1966

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GROSS RADIOACTIVITY IN SURFACE WATERS OF THE UNITED STATES, OCTOBER 1966

Division of Pollution Surveillance
Federal Water Pollution Control Administration
Department of Interior

The monitoring of levels of radioactivity in surface waters of the United States was begun in 1957 as part of the Federal Water Pollution Control Administration's Water Pollution Surveillance System. Table 1 presents the current preliminary results of the alpha and beta particle analysis. The radioactivity associated with dissolved solids provides a rough indication of the levels which would occur in treated water, since nearly all suspended matter is removed by treatment processes. Strontium-90 results are reported semiannually. The stations on each river are arranged in the table according to their distance from the headwaters. Figure 1 indicates the average total beta radioactivity in suspended-plus-dissolved solids in raw water collected at each station. A description of the sampling and analytical procedures was published in the June 1966 issue of *Radiological Health Data and Reports*.

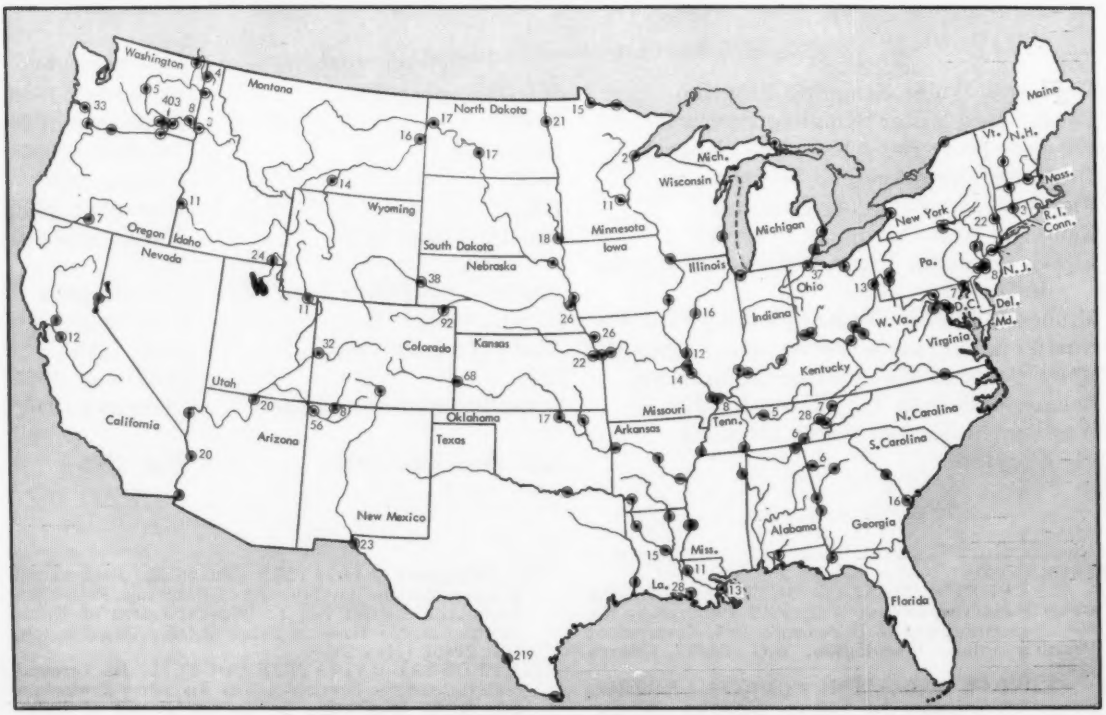

Figure 1. Sampling locations and associated total beta radioactivity (pCi/liter) in surface waters, October 1966

Table 1. Radioactivity in raw surface waters, October 1966

Station	Average beta radioactivity (pCi/liter)			Average alpha radioactivity (pCi/liter)			Station	Average beta radioactivity (pCi/liter)			Average alpha radioactivity (pCi/liter)		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total		Suspended	Dissolved	Total	Suspended	Dissolved	Total
Animas River:							Mississippi River:						
Cedar Hill, N. Mex.	<1	8	8	0	1	1	St. Paul, Minn.	0	11	11	0	0	0
Arkansas River:							E. St. Louis, Ill.	3	11	14	0	1	1
Coolidge, Kans.	26	42	68	10	39	49	New Roads, La.	1	10	11	0	1	1
Ponca City, Okla.	2	15	17	0	0	0	New Orleans, La.	1	12	13	0	2	2
Atchafalaya River:							Missouri River:						
Morgan City, La.	13	15	28	5	1	6	Williston, N. Dak.	4	13	17	0	2	2
Bear River:							Bismarck, N. Dak.	2	15	17	0	2	2
Preston, Idaho	1	23	24	0	1	1	St. Joseph, Mo.	9	17	26	2	3	5
Big Horn River:							North Platte River:						
Hardin, Mont.	4	10	14	1	2	3	Henry, Nebr.	2	36	38	<1	25	25
Big Sioux River:							Ohio River:						
Sioux Falls, S. Dak.	4	14	18	1	2	3	Toronto, Ohio	1	12	13	0	0	0
Chena River:							Cairo, Ill.	2	6	8	0	0	0
Fairbanks, Alaska	1	2	3	0	0	0	Pend Oreille River:						
Clearwater River:							Albeni Falls Dam, Idaho	1	3	4	0	1	1
Lewiston, Idaho	<1	3	3	0	0	0	Platte River:						
Clinch River:							Plattsmouth, Nebr.	8	18	26	2	5	7
Clinton, Tenn.	2	5	7	0	1	1	Rainy River:						
Kingston, Tenn.[a]	12	16	28	<1	1	1	Baudette, Minn.	2	13	15	0	0	0
Colorado River:							Red River, North:						
Loma, Colo.	12	20	32	2	16	18	Grand Forks, N. Dak.	0	21	21	0	1	1
Page, Ariz.	0	20	20	0	5	5	Red River, South:						
Parker Dam, Calif.-Ariz.	2	18	20	0	5	5	Alexandria, La.	3	12	15	1	1	2
Columbia River:							Rio Grande:						
Wenatchee, Wash.	1	4	5	0	1	1	El Paso, Tex.	2	21	23	0	2	2
Pasco, Wash.[a]	40	363	403	0	<1	<1	Laredo, Tex.	201	18	219	70	4	74
Clatskanie, Ore.	6	27	33	0	0	0	San Joaquin River:						
Connecticut River:							Vernalis, Calif.	3	9	12	1	6	7
Enfield Dam, Conn.	0	3	3	0	0	0	San Juan River:						
Coosa River:							Shiprock, N. Mex.	45	11	56	14	3	17
Rome, Ga.	1	5	6	0	0	0	Savannah River:						
Cumberland River:							Port Wentworth, Ga.[a]	3	13	16	0	0	0
Cheatham Lock, Tenn.	1	4	5	0	0	0	Snake River:						
Delaware River:							Payette, Idaho	2	9	11	0	4	4
Philadelphia, Pa.	1	7	8	0	1	1	Wawawai, Wash.	1	7	8	0	1	1
Great Lakes:							South Platte River:						
Duluth, Minn.	0	2	2	0	0	0	Julesburg, Colo.	13	79	92	2	48	50
Green River:							Susquehanna River:						
Dutch John, Utah	1	10	11	0	2	2	Conowingo, Md.	1	6	7	0	0	0
Hudson River:							Tennessee River:						
Poughkeepsie, N.Y.	10	12	22	0	1	1	Chattanooga, Tenn.	3	3	6	<1	0	<1
Illinois River:							Yellowstone River:						
Peoria, Ill.	5	11	16	1	1	2	Sidney, Mont.	5	11	16	1	4	5
Grafton, Ill.	3	9	12	0	1	1							
Kansas River:							Maximum	201	363	403	70	48	74
DeSota, Kans.	7	15	22	1	0	1							
Klamath River:							Minimum	0	2	2	0	0	0
Keno, Ore.	1	6	7	0	0	0							
Maumee River:													
Toledo, Ohio	10	27	37	0	1	1							

[a] Gross beta radioactivity at this station may not be directly comparable to gross beta radioactivity at other stations because of the possible contribution of radionuclides from an upstream nuclear facility in addition to the contribution from fallout and naturally occurring radionuclides common to all stations.

Complete data and exact sampling locations for 1958 through 1963 are published in annual compilations (*1–6*). Detailed data for subsequent years are available on request.

Special note is taken when the alpha radic activity is 15 pCi/liter or greater or when the beta radioactivity is 150 pCi/liter or greater. These arbitrary levels provide a basis for the selection of certain data and for comment on the data, if needed. They reflect no public health significance as the Public Health Service drinking water standards have already provided the basis for this assessment. Changes from or toward these arbitrary levels are also noted in terms of changes in radioactivity per unit weight of solids. No discussion of gross radioactivity per gram of dissolved or suspended solids for all stations of the Water Pollution Surveillance System will be attempted at this time. Comments are made only on monthly average values. Occasional high values from single weekly samples may be absorbed into a relatively low average. When these values are significantly high, comment is made. During both September and October, the following stations showed alpha radioactivity in excess of 15

pCi/liter on either dissolved or suspended solids:

Arkansas River: Coolidge, Kans.
Colorado River: Loma, Colo.
North Platte River: Henry, Nebr.
Rio Grande: Laredo, Tex.
South Platte River: Julesburg, Colo.

The beta radioactivity on suspended solids was greater than 150 pCi/liter for Laredo, Tex., on the Rio Grande. This high value was entirely due to the high solids loading for two samples during this month. On the Columbia River at Pasco, Wash., the beta radioactivity on dissolved solids showed an average of over 150 pCi/liter.

REFERENCES

(1) PUBLIC HEALTH SERVICE, DIVISION OF WATER SUPPLY AND POLLUTION CONTROL. National water quality network annual compilation of data, PHS Publication No. 663, 1958 Edition. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(2) *Ibid.*, 1959 Edition.

(3) *Ibid.*, 1960 Edition.

(4) *Ibid.*, 1961 Edition.

(5) *Ibid.*, 1962 Edition.

(6) PUBLIC HEALTH SERVICE, DIVISION OF WATER SUPPLY AND POLLUTION CONTROL. Water pollution surveillance system, annual compilation of data, PHS Publication No. 663 (Revised), 1963 Edition. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Section III. Air and Deposition

RADIOACTIVITY IN AIRBORNE PARTICULATES AND PRECIPITATION

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fisson product activity. To date, this surveillance has been confined chiefly to gross beta-particle analysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the U.S. Public Health Service, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

An intercomparison of the above networks was performed by Lockhart and Patterson in 1962 and is summarized in the January 1964 issue of *Radiological Health Data*. In addition to the programs presented in this issue, the following programs were previously covered in *Radiological Health Data and Reports:*

Network	Period reported	Last presented
HASL Fallout Network	January-June 1966	March 1967
HASL 80th Meridian Network	Calendar year 1965	January 1967

1. Radiation Surveillance Network December 1966

National Center for Radiological Health
Public Health Service

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Surveillance Network (RSN), which regularly gathers samples from 74 stations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

Daily samples of airborne particulates and precipitation are forwarded to the National Center for Radiological Health, in Rockville, Md., for laboratory analysis. The alerting function of the network is provided by routine field estimates of the gross beta radioactivity made by the station operators prior to submission of the samples. When high air activity is reported. appropriate officials are promptly notified. Compilation of field estimates and laboratory confirmations are reported elsewhere on a monthly basis (*1*). A detailed description of the sampling and analysis procedures was presented in

Table 1. Gross beta radioactivity in surface air and precipitation, December 1966

Station location		Number of samples		Air surveillance gross beta radioactivity (pCi/m³)			Last profile in *RHD&R*	Precipitation	
		Air	Pptn	Maximum	Minimum	Average [a]		Total depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	30	7	0.18	<0.10	<0.11	Nov 66	85	< 17
Alaska:	Adak	31	------	.23	< .10	< .11	June 66	[b]	
	Anchorage	14	3	.26	< .10	< .15	Dec 66	6	< 1
	Attu Island	28	------	.12	< .10	< .10	July 66	[b]	
	Fairbanks	22	1	< .10	< .10	< .10	Jan 67	4	< 1
	Juneau	18	11	.11	< .10	< .10	Feb 67	121	< 24
	Kodiak	14	------	.20	< .10	< .11	Mar 67	[b]	
	Nome	[c]	------	------	------	------	Sept 66	[b]	
	Pt. Barrow	28	------	.23	< .10	< .11	Aug 66	[b]	
	St. Paul Island	[c]	------	------	------	------	Oct 66	[b]	
Ariz:	Phoenix	30	------	.15	< .10	< .11	Feb 67	[b]	
Ark:	Little Rock	24	4	.15	< .10	< .10	Dec 66	97	< 19
Calif:	Berkeley	21	8	< .10	< .10	< .10	Mar 67	108	< 22
	Los Angeles	21	3	< .10	< .10	< .10	Sept 66	131	< 26
C.Z:	Ancón	17	------	< .10	< .10	< .10	Feb 67	[b]	
Colo:	Denver	30	1	.13	< .10	< .10	Mar 67	4	< 1
Conn:	Hartford	31	10	.13	< .10	< .10	Jan 67	57	< 12
Del:	Dover	20	------	.11	< .10	< .10	Nov 66	[b]	
D.C:	Washington	30	7	.23	< .10	< .11	Aug 66	93	< 19
Fla:	Jacksonville	31	4	.60	< .10	< .13	Dec 66	66	< 13
	Miami	29	4	.15	< .10	< .10	Jan 67	35	< 7
Ga:	Atlanta	31	3	.22	< .10	< .11	Oct 66	10	< 2
Guam:	Agana	31	------	< .10	< .10	< .10	Nov 66	[b]	
Hawaii:	Honolulu	30	6	< .10	< .10	< .10	July 66	82	< 16
Idaho:	Boise	26	7	< .10	< .10	< .10	July 66	25	< 5
Ill:	Springfield	30	5	.21	< .10	< .11	Aug 66	74	< 15
Ind:	Indianapolis	31	9	.20	< .10	< .11	Oct 66	127	< 25
Iowa:	Iowa City	31	8	.21	< .10	< .11	Feb 67	30	< 6
Kans:	Topeka	31	4	.18	< .10	< .11	Dec 66	8	< 2
Ky:	Frankfort	28	9	.16	< .10	< .11	Aug 66	55	< 11
La:	New Orleans	31	9	.14	< .10	< .11	Aug 66	137	< 28
Maine:	Augusta	30	11	.11	< .10	< .10	Sept 66	100	< 20
	Presque Isle	17	------	< .10	< .10	< .10	Feb 67	[b]	
Md:	Baltimore	21	5	.15	< .10	< .11	Jan 67	45	< 9
	Rockville	17	------	.13	< .10	< .10	July 66	[b]	
Mass:	Lawrence	29	8	.17	< .10	< .11	Nov 66	77	< 16
	Winchester	20	8	.12	< .10	< .10	Mar 67	69	< 14
Mich:	Lansing	30	------	.18	< .10	< .11	July 66	[b]	
Minn:	Minneapolis	21	6	.16	< .10	< .10	Nov 66	18	< 4
Miss:	Jackson	30	6	.14	< .10	< .10	Sept 66	91	< 18
Mo:	Jefferson City	29	5	.15	< .10	< .10	Oct 66	56	< 11
Mont:	Helena	31	3	< .10	< .10	< .10	June 66	10	< 2
Nebr:	Lincoln	19	2	.90	< .10	< .11	Oct 66	21	<134
Nev:	Las Vegas	26	------	.12	< .10	< .10	Jan 67	[b]	
N.H:	Concord	18	------	.12	< .10	< .10	Aug 66	[b]	
N.J:	Trenton	31	6	.13	< .10	< .10	Sept 66	19	< 4
N. Mex:	Santa Fe	26	3	.13	< .10	< .10	June 66	13	< 3
N.Y:	Albany	21	10	.11	< .10	< .10	Oct 66	58	< 12
	Buffalo	19	------	.14	< .10	< .10	Feb 67	[b]	
	New York	31	------	.13	< .10	< .10	Mar 67	[b]	
N.C:	Gastonia	31	4	.21	< .10	< .11	Feb 67	50	< 10
N. Dak:	Bismarck	31	2	.19	< .10	< .11	Aug 66	4	< 1
Ohio:	Cincinnati	12	------	.19	< .10	< .11	Nov 66	[b]	
	Columbus	31	9	.24	< .10	< .12	Sept 66	68	< 14
	Painesville	30	15	.13	< .10	< .10	Jan 67	113	< 23
Okla:	Oklahoma City	23	5	< .10	< .10	< .10	July 66	13	< 3
	Ponca City	28	3	< .10	< .10	< .10	Jan 67	16	< 3
Ore:	Portland	30	19	< .10	< .10	< .10	Oct 66	124	< 25
Pa:	Harrisburg	30	2	.11	< .10	< .10	Oct 66	24	< 5
P.R:	San Juan	30	7	.22	< .10	< .10	Sept 66	195	< 39
R.I:	Providence	28	7	< .10	< .10	< .10	July 66	56	< 11
S.C:	Columbia	29	8	.15	< .10	< .10	Mar 67	77	< 15
S. Dak:	Pierre	30	------	.14	< .10	< .10	Feb 67	[b]	
Tenn:	Nashville	31	8	.16	< .10	< .10	July 66	119	< 24
Tex:	Austin	31	5	.13	< .10	< .10	Nov 66	20	< 4
	El Paso	31	------	.13	< .10	< .10	Aug 66	[b]	
Utah:	Salt Lake City	30	7	.19	< .10	< .10	Sept 66	21	< 4
Vt:	Barre	30	13	.13	< .10	< .10	Dec 66	78	< 16
Va:	Richmond	31	8	.12	< .10	< .10	Dec 66	58	< 12
Wash:	Seattle	29	20	< .10	< .10	< .10	Dec 66	128	< 27
	Spokane	31	8	< .10	< .10	< .10	Nov 66	54	< 11
W. Va:	Charleston	31	12	.18	< .10	< .10	Mar 67	57	< 11
Wis:	Madison	30	7	.14	< .10	< .10	Dec 66	72	< 14
Wyo:	Cheyenne	31	1	.12	< .10	< .10	Jan 67	2	< 1
Network summary		1,934	366	0.60	<0.10	<0.10	------	61	< 15

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values of <0.10 are assumed to be 0.10 for averaging purposes. If 10 percent or more samples from a station contain <0.10 pCi/m³, a less-than sign is placed before the average.
[b] No precipitation sample collected.
[c] No report received.

Figure 1. Radiation Surveillance Network sampling stations

the November 1966 issue of *Radiological Health Data and Reports*.

Table 1 presents the monthly average gross beta radioactivity in surface air and deposition by precipitation during December 1966. Time profiles of gross beta radioactivity in air for eight RSN stations are shown in figure 2.

Gross beta radioactivity in December air samples have decreased to levels slightly above those existing prior to the Chinese mainland test of October 27, 1966, EST. The most active sample was collected at Lincoln, Nebr., on December 28, 1966, and measured 0.90 pCi/m^3 on January 5, 1967. The only other sample more active than 0.3 pCi/m^3 was the December 2, 1966, Jacksonville, Fla., sample, which measured 0.6 pCi/m^3.

A total of 311 network air samples were gamma-scanned in December, and fresh fission products were identified on the air samples listed in table 2.

Table 2. Fresh fission products identified in RSN air samples, December 1966

Location		Date December 1966
Alaska:	Anchorage	1
	Point Barrow	29, 30, 31
Ga:	Atlanta	2
Nebr:	Lincoln	28

Precipitation radioactivity levels, with one exception, were at or near minimum reporting levels. Only seven samples were more active than 200 pCi/liter. The most active precipitation sample, and the only one to exceed 400 pCi/liter, was collected at Lincoln, Nebr., on December 28, 1966, contained 511,500 pCi/liter at the time of collection, and represented a deposition of 133.4 nCi/m^2 of gross beta radioactivity. The presence of fresh fission products was confirmed in this sample by gamma-ray spectrometry.

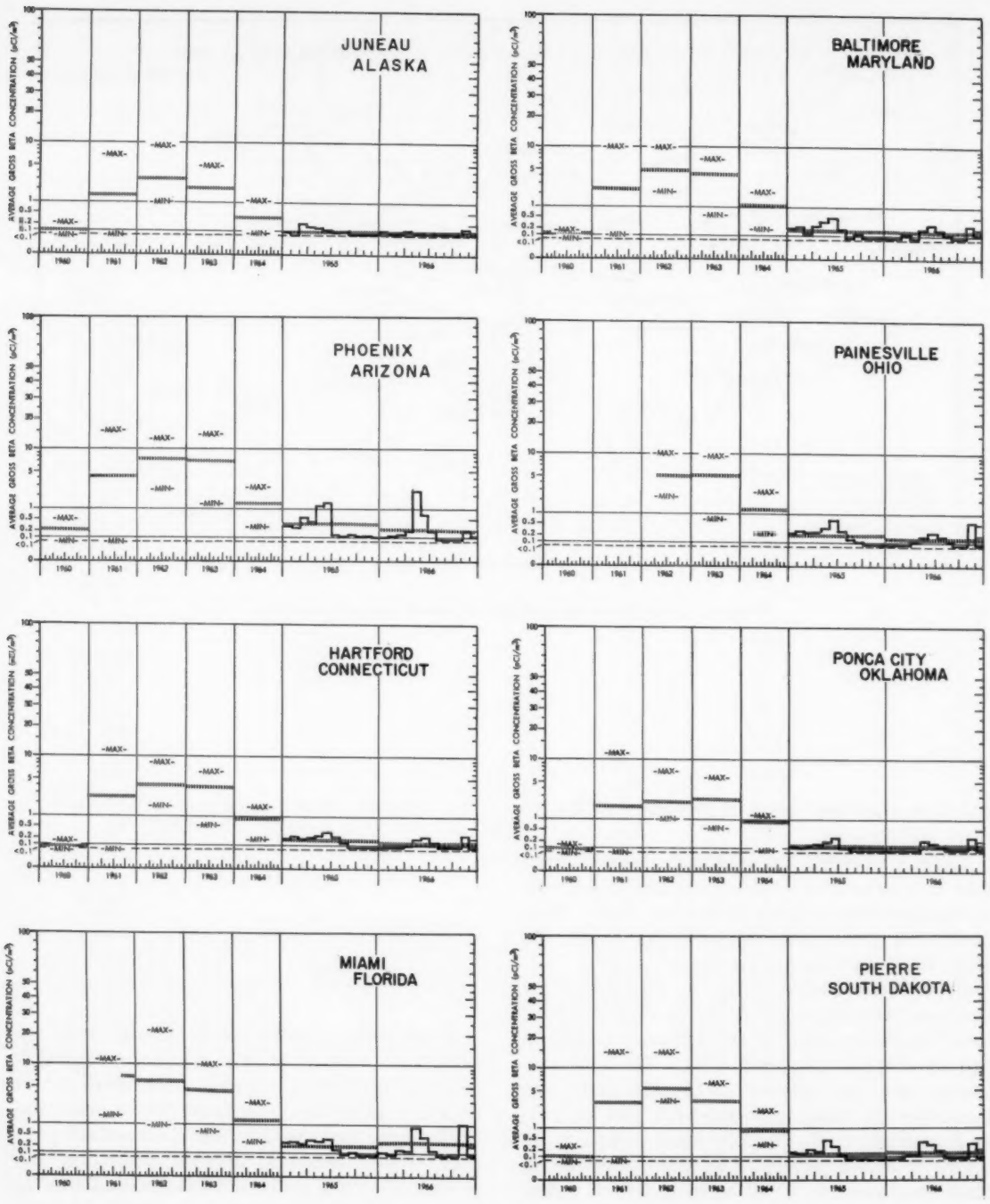

Figure 2. Monthly and yearly profiles of beta radioactivity in air—Radiation Surveillance Network, 1960–December 1966

2. Canadian Air and Precipitation Monitoring Program December 1966[1]

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport (figure 3), Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*2–6*).

A summary of the sampling procedures and methods of analysis was presented in the November 1966 issue of *Radiological Health Data and Reports.*

[1] Prepared from information and data in the January 1967 monthly report "Data from Radiation Protection Program," Canadian Department of National Health and Welfare, Ottawa, Canada.

Surface air and precipitation data for December 1966 are presented in table 3.

Table 3. Canadian gross beta radioactivity in surface air and precipitation, December 1966

Station	Number of samples	Air surveillance radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentrations (pCi/liter)	Total deposition (nCi/m²)
Calgary	31	0.2	0.0	0.1	9,077	36.9
Coral Harbour	31	.2	.0	.1	88	.3
Edmonton	31	.2	.0	.1	205	2.7
Ft. Churchill	31	.2	.0	.1	7	.2
Ft. William	31	.2	.0	.1	14	.5
Fredericton	29	.2	.0	.1	4	.3
Goose Bay	31	.2	.0	.1	9	1.2
Halifax	31	.2	.0	.1	3	.4
Inuvik	31	.2	.0	.1	14	.3
Montreal	22	.2	.0	.1	7	7
Moosonee	30	.1	.0	.1	N8	N8
Ottawa	30	.2	.0	.1	9	1.1
Quebec	31	.2	.0	.1	10	1.0
Regina	31	.2	.0	.1	47	.5
Resolute	31	.2	.0	.1	41	.2
St. John's, Nfld.	31	.2	.0	.0	5	1.2
Saskatoon	31	.2	.0	.1	24	.3
Sault Ste. Marie	30	.2	.0	.1	8	.6
Toronto	30	.2	.0	.1	6	.6
Vancouver	31	.1	.0	.0	17	4.2
Whitehorse	31	.2	.0	.1	532	2.7
Windsor	31	.2	.0	.1	10	1.2
Winnipeg	31	.2	.0	.1	219	4.6
Yellowknife	30	.2	.0	.1	11	.2
Network summary		0.2	0.0	0.1	451	2.7

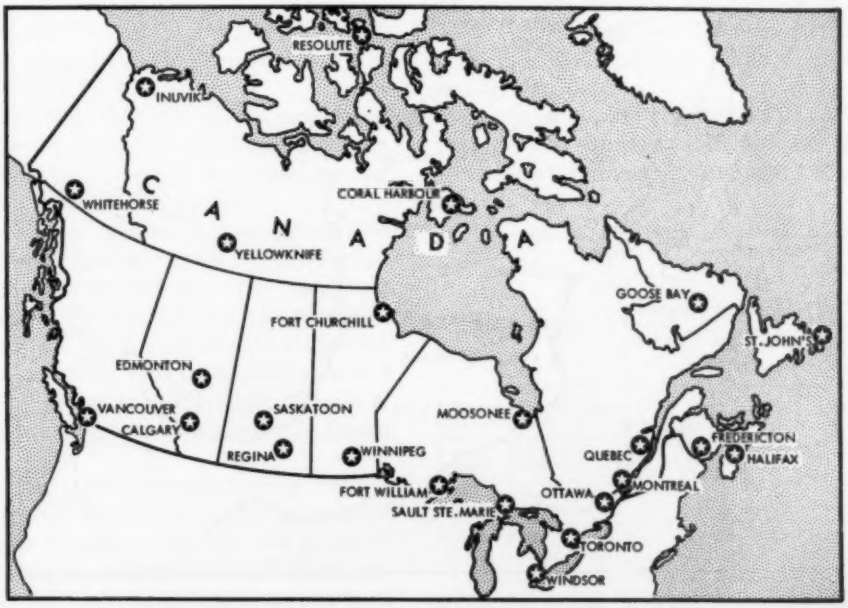

Figure 3. Canadian air and precipitation sampling stations

3. Mexican Air Monitoring Program December 1966

National Commission of Nuclear Energy

The Radiation Surveillance Network of Mexico was established by the Comisión Nacional de Energía Nuclear (CNEN), México, D.F. From 1952 to 1961, the network was directed by the Institute of Physics of the University of Mexico, under contract to the CNEN.

In 1961, the CNEN appointed its Division of Radiological Protection to establish a new radiation surveillance network. In 1966, the Division of Radiological Protection was restructured and its name changed to Dirección General de Seguridad Radiológica (DRS). The network consists of 16 stations (figure 4), 11 of which are located at airports and operated by airline personnel. The remaining five stations are located at México, D.F., Mérida, Veracruz, San Luis Potosí, and Ensenada. Staff members of the DRS operate the station at México, D.F., while the other four stations are manned by members of the Centro de Previsión del Golfo de México, the Chemistry Department of the University of Mérida, the Instituto de Zonas Desérticas of the University of San Luis Potosí, and the Escuela Superior de Ciencias Marinas of the University of Baja California, respectively.

Sampling

The sampling procedure involves drawing air through a high-efficiency 6- by 9-inch glass-fiber filter for 20 hours a day, 3 or 4 days a week at the rate of 1,000 cubic meters per day using high-volume samplers.

After each 20-hour sampling period, the filter is removed and shipped via airmail to the Sección de Radioactividad Ambiental, CNEN, in México, D.F., for assay of gross beta radioactivity, allowing a minimum of 3 or 4 days after collection for the decay of radon and thoron. The data are not extrapolated to the time of collection. Statistically, it has been found that a minimum of eight samples per month were needed to get a reliable average activity at each station (*7*).

Figure 4. Mexican air sampling locations

The maximum, minimum, and average gross beta radioactivity in surface air during December 1966 are presented in table 4.

Table 4. Mexican gross beta radioactivity of airborne particulates, December 1966

Station	Number of samples	Gross beta radioactivity (pCi/m³)		
		Maximum	Minimum	Average
Acapulco	14	0.1	<0.1	0.1
Chihuahua	11	.1	.1	.1
Ciudad Juárez	12	.1	< .1	.1
Ensenada	13	.2	< .1	.1
Guadalajara	1			.1
Guaymas	1			< .1
La Paz	21	.1	< .1	.1
Matamoros	NS			
Mazatlán	9	.1	.1	.1
Mérida	17	.1	< .1	.1
México, D.F.	9	.1	.1	.1
Nuevo Laredo	6	.1	< .1	.1
San Luis Potosí	NS			
Tampico	NS			
Torreón	19	.2	.1	.1
Veracruz	9	.1	< .1	.1

NS, no sample collected, station temporarily shutdown.

Figure 5. Pan American Air Sampling Program stations

4. Pan American Air Sampling Program December 1966

Pan American Health Organization and *U.S. Public Health Service*

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the U.S. Public Health Service (PHS) to assist PAHO-member countries in developing radiological health programs. The sampling equipment and analytical services are provided by the National Center for Radiological Health, PHS, and are identical with those employed for the Radiation Surveillance Network. The air-sampling station locations are shown in figure 5.

The December 1966 air-monitoring results are given in table 5. Levels continue to decrease and all samples received from stations north of the equator were at or below the minimum reporting level (0.10 pCi/m³). Stations south of the equator were still slightly elevated. The most active sample was collected at Buenos Aires, Argentina, on December 1, 1966, and measured 0.38 pCi/m³ when counted on December 19, 1966.

No fresh fission products were identified on the 32 air samples analyzed by gamma-ray spectrometry during December 1966.

Table 5. PAHO gross beta radioactivity in surface air, December 1966

Station location	Number of samples	Gross beta radioactivity (pCi/m³)		
		Maximum	Minimum	Average [a]
Argentina: Buenos Aires	13	0.38	<0.10	0.21
Chile: Santiago	27	.26	< .10	< .17
Colombia: Bogota	20	< .10	< .10	< .10
Ecuador: Guayaquil	28	.36	< .10	.24
Jamaica: Kingston	11	< .10	< .10	< .10
Peru: Lima	NS			
Venezuela: Caracas	16	< .10	< .10	< .10
West Indies: Trinidad	13	< .10	< .10	< .10
Pan American summary	128	.38	< .10	< .14

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values of <0.10 are assumed to be 0.10 for averaging purposes. If 10 percent or more samples from a station contain <0.10 pCi/m³, a less-than sign is placed before the average.
NS, no sample reported.

5. National Air Sampling Network October-December and annual summary, 1966

National Center for Air Pollution Control
Public Health Service

The necessity of having basic data on the nature and extent of air pollution throughout the United States led to the organization of the National Air Sampling Network (NASN) in 1953. The NASN analyzes air samples for the total quantity of airborne particulate matter, benzene-soluble organic matter, and gross beta radioactivity. Selected samples are also analyzed for nitrates, sulfates, and a number of metals. The resulting data aid in the detection of trends in levels of pollution with respect to time, location, population density, climate, and other factors.

NASN stations (figure 6) are manned by cooperating Federal, State, and local agencies. The current basic network consists of 110 sampling stations which operate every year in 73 large cities and 37 non-urban areas. In addition, there are stations in 130 cities which operate every other year. Thus, the NASN consists of 240 sampling stations, 175 of which are active in any given year.

Gross beta radioactivity in air

Continuous 24-hour samples of airborne particulate matter are taken at each station. The samples, representing approximately 2,000 cubic meters of air, are collected on glass-fiber filters on a biweekly random sampling schedule. They are sent for analysis to the network laboratory at the Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio. October to December 1966 gross beta radioactivity in air is given in table 6. The summary for 1966 is presented in table 7.

Figure 6. National Air Sampling Network locations, 1966

Table 6. NASN fission product gross beta radioactivity in surface air, October–December 1966

Station		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average
Ala:	Birmingham	6	0.3	0.1	0.2
	Gadsden	6	2.1	< .1	.4
	Mobile	6	1.3	< .1	.3
Alaska:	Anchorage	6	.2	< .1	.1
Ariz:	Grand Canyon Park *	5	.2	.1	.1
	Paradise Valley	6	.2	.1	.1
	Phoenix	6	.3	.1	.2
	Tucson	5	.2	.1	.1
Ark:	Little Rock	6	1.6	.1	.4
	Montgomery County *	6	1.2	.1	.3
	Texarkana	4	.2	.1	.1
	West Memphis	6	4.4	< .1	.8
Calif:	Burbank	6	.6	< .1	.2
	Humboldt County *	6	.1	< .1	.1
	Los Angeles	6	.4	< .1	.1
	Oakland	7	.3	.1	.1
	Pasadena	6	.7	.1	.2
	San Diego	6	.2	.1	.1
	San Francisco	6	.2	< .1	.1
Colo:	Denver	5	1.5	< .1	.4
	Montezuma County *	6	.2	.1	.2
Conn:	Hartford	6	.2	< .1	.1
	New Haven	5	.3	< .1	.1
Del:	Kent County *	5	.1	< .1	.1
	Newark	6	.3	.1	.1
	Wilmington	5	.5	< .1	.2
D.C:	Washington	7	.7	.1	.2
Ga:	Atlanta	5	.3	.1	.2
Hawaii:	Honolulu	6	.5	< .1	.1
Idaho:	Boise	5	.4	.1	.2
	Butte County *	3	.6	.1	.3
Ill:	Chicago	6	3.1	< .1	.6
Ind:	East Chicago				
	Hammond				
	Indianapolis				
	N. Monroe State Forest *	5	1.7	.1	.4
	Muncie	5	.4	.1	.2
	New Albany	6	.3	.1	.2
	Parke County *	5	1.4	< .1	.4
	South Bend	6	.6	.1	.2
	Terre Haute	2	.1	.1	.1
Iowa:	Davenport	6	.1	< .1	.1
	Delaware County *	6	.2	.1	.1
	Des Moines	5	2.1	.1	.5
	Dubuque	6	.3	.1	.2
Kans:	Kansas City	5	1.5	.1	.4
	Wichita	6	.4	.1	.2
Ky:	Ashland	6	2.9	< .1	.6
	Covington	6	3.5	< .1	.7
	Louisville	6	.3	< .1	.1
La:	New Orleans	6	1.4	.1	.3
Maine:	Acadia National Park *	5	.1	< .1	.1
	Portland	4	.5	< .1	.2
Md:	Baltimore	6	.4	.1	.2
	Calvert County *	6	.4	.1	.2
Mich:	Detroit	6	3.4	.1	.7
Minn:	Duluth	6	.3	.1	.2
	Minneapolis	6	.3	< .1	.1
	Moorhead	6	.2	< .1	.1
	St. Paul	6	.2	< .1	.1
Miss:	Jackson	6	1.9	< .1	.4
	Jackson County *	6	1.5	.1	.4
Mo:	Kansas City	5	3.9	.1	.9
	St. Louis	6	5.1	.1	.9
	Shannon County *	6	3.0	< .1	.6
Mont:	Glacier National Park *	5	.2	< .1	.1
	Helena	6	.2	< .1	.1
Nebr:	Omaha	6	.2	.1	.1
	Thomas County *	6	.5	.1	.2
Nev:	Las Vegas	6	0.5	0.1	0.2
	White Pine County *	5	.2	< .1	.1
N.H:	Concord	6	.3	< .1	.2
	Coos County *	6	.5	< .1	.2
N.J:	Marlton	6	.3	.1	.1
	Camden	6	.2	< .1	.1
	Glassboro	6	.3	< .1	.1
	Jersey City	6	.6	< .1	.2
	Newark	5	.1	.1	.1
	Perth Amboy	6	.2	.1	.1
	Trenton	6	.3	.1	.1
N. Mex:	Albuquerque	5	.2	< .1	.1
	Rio Arriba County *	6	.1	.1	.1
N.Y:	Cape Vincent *	6	.5	< .1	.2
	New York	5	4.1	.1	.9
N.C:	Charlotte	6	.9	.1	.3
	Cape Hatteras *	6	.3	.1	.2
Ohio:	Akron	6	1.9	.1	.4
	Cincinnati	6	3.9	< .1	.7
	Cleveland	6	.3	< .1	.1
	Columbus	5	3.6	< .1	.8
	Dayton	6	3.2	< .1	.6
	Toledo	6	3.2	.1	.7
	Youngstown	6	1.2	< .1	.3
Okla:	Cherokee County *	6	1.4	.1	.4
	Oklahoma City	6	3.5	.1	.7
	Tulsa	5	.2	.1	.1
Ore:	Curry County *	6	.2	< .1	.1
	Portland	5	10.4	< .1	2.1
Pa:	Clarion County *	6	1.0	.1	.3
	Lancaster	6	.2	.1	.1
	Philadelphia	6	.3	< .1	.1
	Pittsburgh	6	.9	< .1	.2
	Reading	6	.3	.1	.2
	Warminster	6	.6	< .1	.2
	West Chester	4	.1	< .1	.1
P.R:	Bayamón	6	.2	< .1	.1
	Guayanilla	5	.1	< .1	.1
	Ponce	6	.1	< .1	.0
	San Juan	6	.1	< .1	.1
R.I:	Providence	5	.7	.1	.3
	Washington County *	6	.3	< .1	.1
S.C:	Columbia	4	.2	.1	.1
	Greenville	6	1.3	.1	.4
	Richland County *	6	.2	< .1	.1
S. Dak:	Black Hills Forest *	6	.2	.1	.1
	Sioux Falls	6	.2	.1	.1
Tenn:	Chattanooga	5	.3	.1	.2
	Memphis	6	4.8	.1	.9
	Nashville	5	.4	< .1	.2
Tex:	Dallas	5	1.7	.1	.4
	Houston	7	1.0	.1	.2
	Matagorda County *	6	.6	.1	.2
	Pasadena	6	.8	< .1	.2
	San Antonio	6	1.7	.1	.4
Utah:	Ogden	5	.3	< .1	.1
	Salt Lake City	5	.2	.1	.1
Vt:	Burlington	5	.3	< .1	.1
	Orange County *	6	.3	< .1	.1
Va:	Danville	6	.3	< .1	.1
	Norfolk	6	.2	< .1	.1
	Shenandoah Nat'l Park *	5	.2	< .1	.1
Wash:	Seattle	6	.2	< .1	.1
W. Va:	Charleston	5	.8	.1	.2
Wis:	Door County *	4	.2	.1	.1
	Milwaukee	6	3.5	.1	.7
Wyo:	Casper	4	.2	.1	.2
	Cheyene	6	1.1	.1	.3
	Yellowstone Park *	6	.4	.1	.2

* Nonurban station

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Table 7. NASN fission product gross beta radioactivity in surface air, annual summary 1966

Station		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average
Ala:	Birmingham	25	0.7	0.1	0.2
	Gadsden	26	2.1	< .1	.2
	Mobile	26	1.3	< .0	.2
Alaska:	Anchorage	21	.3	< .1	.1
Ariz:	Grand Canyon Park *	25	6.7	< .1	.5
	Paradise Valley	26	10.8	.1	.6
	Phoenix	24	7.4	.1	.6
	Tucson	25	4.7	< .1	.4
Ark:	Little Rock	26	1.6	.1	.3
	Montgomery County *	25	1.2	.1	.2
	Texarkana	22	.5	.1	.2
	West Memphis	26	4.4	< .1	.4
Calif:	Burbank	26	1.4	.1	.2
	Humboldt County *	24	.2	< .1	.1
	Los Angeles	26	4.6	< .1	.3
	Oakland	25	.4	.1	.2
	Pasadena	25	1.9	.1	.2
	San Diego	24	2.2	< .1	.2
	San Francisco	26	.4	< .1	.1
Colo:	Denver	25	1.5	< .1	.3
	Montezuma County *	26	5.3	.1	.5
Conn:	Hartford	26	.5	< .1	.2
	New Haven	25	.4	< .0	.2
Del:	Kent County *	25	.6	< .1	.2
	Newark	25	.5	.1	.2
	Wilmington	24	1.8	< .1	.2
D.C:	Washington	25	.7	< .1	.2
Ga:	Atlanta	23	1.0	< .1	.2
Hawaii:	Honolulu	26	1.8	< .1	.2
Idaho:	Boise	25	.6	.1	.2
	Butte County *	23	.8	.1	.2
Ill:	Chicago	26	3.1	< .1	.3
Ind:	East Chicago	26	3.3	.1	.3
	Hammond	24	.5	< .1	.2
	Indianapolis	25	2.8	.1	.3
	N. Monroe State Forest *	22	1.7	< .1	.3
	Muncie	24	.5	.1	.2
	New Albany	24	.8	< .1	.2
	Parke County *	25	1.4	< .1	.2
	South Bend	24	.6	.1	.2
	Terre Haute	20	.7	.1	.2
Iowa:	Davenport	25	.8	< .1	.2
	Delaware County *	23	.4	< .1	.1
	Des Moines	25	2.1	.1	.2
	Dubuque	26	.4	.1	.2
Kans:	Kansas City	23	1.5	.1	.2
	Wichita	25	.6	.1	.2
Ky:	Ashland	25	2.9	< .1	.3
	Covington	26	3.5	< .1	.3
	Louisville	25	.7	< .1	.2
La:	New Orleans	26	1.4	.1	.3
Maine:	Acadia National Park *	24	.3	< .1	.1
	Portland	19	.5	< .1	.1
Md:	Baltimore	26	.5	< .1	.2
	Calvert County *	25	.4	< .1	.2
Mich:	Detroit	26	3.4	< .1	.3
Minn:	Duluth	26	.5	.1	.2
	Minneapolis	26	.5	< .1	.2
	Moorhead	26	.4	< .1	.1
	St. Paul	25	.4	< .1	.2
Miss:	Jackson	26	1.9	< .1	.3
	Jackson County *	26	1.5	< .1	.2
Mo:	Kansas City	24	3.9	.1	.3
	St. Louis	24	5.1	.1	.4
	Shannon County *	24	3.0	< .1	.3
Mont:	Glacier National Park *	24	.9	< .1	.2
	Helena	26	1.1	< .1	.2
Nebr:	Omaha	25	.4	.1	.2
	Thomas County *	26	.8	.1	.2
Nev:	Las Vegas	26	5.9	0.1	0.5
	White Pine County *	23	8.6	< .1	.5
N.H:	Concord	26	.8	< .1	.2
	Coos County *	25	.5	< .1	.2
N.J:	Marlton	26	.5	< .1	.2
	Camden	25	.4	< .1	.2
	Glassboro	26	.5	< .1	.2
	Jersey City	23	.6	< .1	.2
	Newark	25	.4	< .1	.1
	Perth Amboy	24	.5	.1	.2
	Trenton	22	.3	< .1	.1
N. Mex:	Albuquerque	25	3.5	< .1	.4
	Rio Arriba County *	24	1.9	.1	.3
N.Y:	Cape Vincent *	25	.5	< .1	.2
	New York	24	4.1	< .1	.3
N.C:	Charlotte	26	.9	< .1	.2
	Cape Hatteras *	23	.6	< .1	.1
Ohio:	Akron	25	1.9	< .1	.3
	Cincinnati	25	3.9	< .1	.3
	Cleveland	26	.7	< .1	.2
	Columbus	25	3.6	< .1	.4
	Dayton	26	3.2	< .1	.3
	Toledo	26	3.2	< .1	.3
	Youngstown	26	1.2	< .1	.2
Okla:	Cherokee County *	26	1.4	.1	.2
	Oklahoma City	26	3.5	.1	.4
	Tulsa	25	.9	.1	.3
Ore:	Curry County *	24	.2	< .1	.1
	Portland	22	10.4	< .1	.6
Pa:	Clarion County *	24	1.0	.1	.2
	Lancaster	26	.9	.1	.2
	Philadelphia	24	.6	< .1	.2
	Pittsburgh	26	.9	< .1	.2
	Reading	25	.7	< .1	.2
	Warminster	24	.6	< .1	.2
	West Chester	19	.7	< .1	.2
P.R:	Bayamon	26	.7	< .1	.1
	Guayanilla	25	1.1	< .1	.2
	Ponce	26	.5	< .1	.1
	San Juan	25	1.6	< .1	.2
R.I:	Providence	24	.7	.1	.2
	Washington County *	23	.4	< .1	.2
S.C:	Columbia	23	.8	.1	.2
	Greenville	26	1.3	.1	.2
	Richland County *	26	.4	< .1	.2
S. Dak:	Black Hills Forest *	25	.6	.1	.2
	Sioux Falls	26	1.8	< .1	.2
Tenn:	Chattanooga	23	.7	< .1	.2
	Memphis	26	4.8	.1	.4
	Nashville	24	.5	< .1	.2
Tex:	Dallas	24	1.7	.1	.3
	Houston	26	1.0	< .1	.2
	Matagorda County *	23	1.2	< .1	.2
	Pasadena	10	.8	< .1	.2
	San Antonio	25	1.7	< .1	.2
Utah:	Ogden	24	.9	< .1	.2
	Salt Lake City	24	1.9	.1	.3
Vt:	Burlington	25	.9	< .1	.2
	Orange County *	26	.6	< .1	.2
Va:	Danville	24	1.4	< .1	.3
	Norfolk	26	.4	< .1	.1
	Shenandoah Nat'l Park *	25	.4	< .1	.1
Wash:	Seattle	26	.3	< .1	.1
W. Va:	Charleston	22	.8	.1	.2
Wis:	Door County *	19	.2	< .1	.1
	Milwaukee	25	3.5	< .1	.3
Wyo:	Casper	4	.2	.1	.2
	Cheyenne	26	1.1	.1	.3
	Yellowstone Park *	25	1.7	.1	.3

* Nonurban station

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Section IV. Other Data

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included are such data as those obtained from human bone sampling, bovine thyroid sampling, and environmental monitoring reports.

IODINE-131 IN BOVINE THYROIDS, JULY–DECEMBER 1966

National Center for Radiological Health
Public Health Service

To supplement its existing environmental surveillance systems, the National Center for Radiological Health established a Bovine Thyroid Network in October 1964 (*1*). Specimens are collected by the Meat Inspection Division, U.S. Department of Agriculture, and analyzed by gamma-ray spectrometry for iodine-131 content at the Northeastern Radiological Health Laboratory, Winchester, Mass.

The network consists of collection areas (countries shaded in figure 1) located so as to cover, as nearly as possible, areas near major nuclear reactors, spent-fuel reprocessing plants, and nuclear test sites. Details of sampling and analysis have been published earlier (*1*). For this report, the collection areas sampled during July through December 1966 were grouped on a broad geographical basis as shown in figure 1.

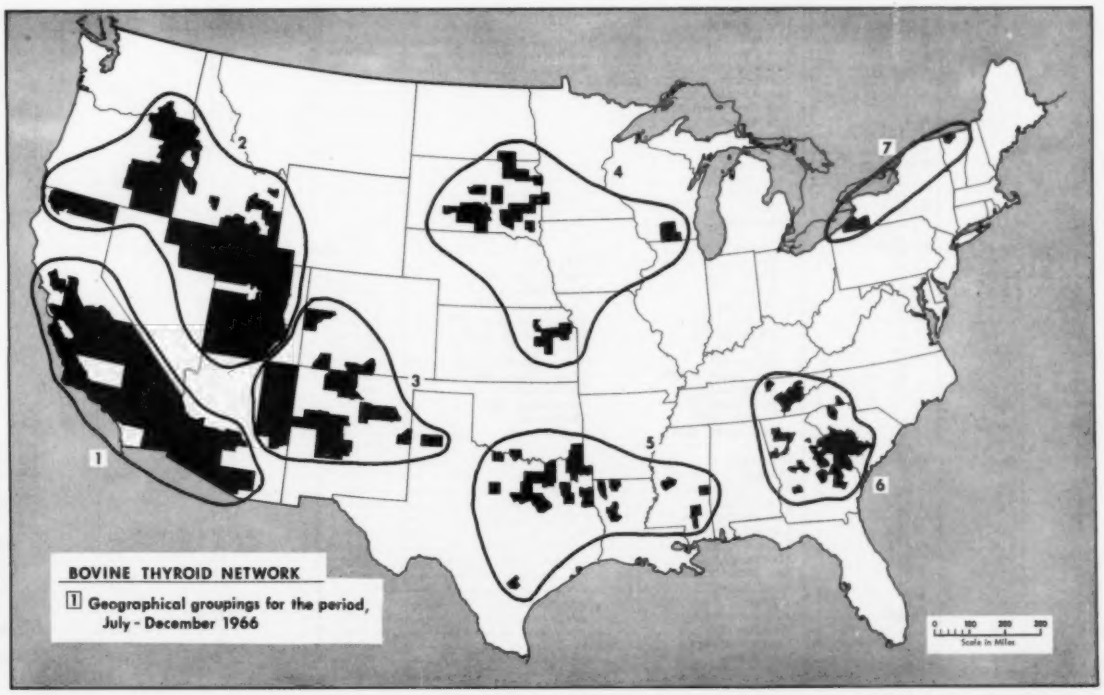

Figure 1. Counties sampled in bovine thyroid network, July–December 1966

Table 1. Iodine-131 in bovine thyroids, July–December 1966

Geographical grouping [a]	Date of slaughter	County of origin	Number of samples	pCi iodine-131/g thyroid		
				Average or concentration	Minimum	Maximum
1 Southwestern Arizona and California	7/1	Kings	1	ND		
		San Bernardino	2	ND		
		San Luis Obispo	1	ND		
	7/5	Merced	4	ND		
		Stanislaus	2	ND		
	7/6	Los Angeles	2	ND		
		San Joaquin	2	2	ND	3
		Santa Clara	2	9	8	10
	7/7	Los Angeles	2	25	24	26
		San Bernardino	4	16	15	18
	7/8	Kings	2	21	ND	41
		Los Angeles	1	6		
		Ventura	1	2		
	7/11	Merced	2	3	ND	3
		Stanislaus	4	<1	ND	3
	7/12	Los Angeles	2	1	ND	2
		San Joaquin	2	2	ND	3
		Santa Clara	2	12	11	12
	7/13	Los Angeles	2	1	ND	2
	7/15	Los Angeles	2	4	ND	2
		Stanislaus	1	ND		
		Tulare	1	2		
	7/18	Los Angeles	2	4	ND	8
		San Joaquin	2	24	21	26
		Santa Barbara	1	ND		
		Stanislaus	2	30	27	32
	7/19	Merced	2	ND		
		San Joaquin	2	15	ND	30
	7/20	Los Angeles	1	ND		
	7/21	San Bernardino	2	1	ND	2
	7/22	Los Angeles	3	4	3	4
		Tulare	2	ND		
		Ventura	1	ND		
	7/25	Los Angeles	2	ND		
		Merced	4	8	3	13
		Stanislaus	2	5	3	7
	7/26	Los Angeles	3	ND		
		Merced	2	ND		
		Stanislaus	2	2	ND	4
	7/27	Riverside	1	ND		
	7/28	San Joaquin	2	ND		
	7/29	Los Angeles	2	ND		
	8/1	Merced	4	ND		
		San Joaquin	2	ND		
	8/2	San Joaquin	2	8	5	11
		Stanislaus	2	8	7	9
	8/3	Los Angeles	2	2	ND	3
		San Bernardino	2	ND		
	8/4	Los Angeles	1	ND		
		Riverside	1	ND		
	8/6	Tulare	2	ND		
	8/8	Monterey	2	ND		
		Sacramento	2	2	ND	4
		Stanislaus	2	ND		
	8/9	Fresno	3	ND		
		Stanislaus	4	7	ND	16
	8/10–11/7 [b]	[Arizona] [c]	235	[d] ND		
		Maricopa (21) [e]				
		Pinal (0)				
		Yuma (1)				
		[California]				
		Fresno (11)				
		Imperial (0)				
		Inyo (1)				
		Kings (9)				
		Los Angeles (53)				
		Madera (2)				
		Mariposa (0)				
		Merced (20)				
		Monterey (22)				
		Napa (1)				
		Orange (2)				
		Riverside (5)				
		Sacramento (11)				
		San Bernardino (9)				
		San Joaquin (31)				
		San Luis Obispo (1)				
		Santa Barbara (4)				
		Santa Clara (0)				
		Solano (1)				
		Stanislaus (29)				
		Tulare (1)				
		Ventura (0)				
	11/8	Imperial	2	ND		
		Merced	2	6	ND	12
		San Bernardino	2	ND		
		San Joaquin	2	7	4	10
	11/9	San Bernardino	2	ND		
	11/10	Los Angeles	2	ND		
	11/14	Fresno	2	18	17	20
		Monterey	2	33	25	41
		San Bernardino	2	5	ND	10
		Stanislaus	2	13	ND	16
		Tulare	2	ND		
	11/15	San Bernardino	2	ND		
		San Joaquin	2	1	ND	2
		Santa Barbara	1	39		
		Stanislaus	2	5	ND	10

See footnotes at end of table.

Table 1. Iodine-131 in bovine thyroids, July–December 1966—Continued

Geographical grouping [a]	Date of slaughter	County of origin	Number of samples	pCi iodine-131/g thyroid		
				Average or concentration	Minimum	Maximum
1 Continued						
	11/18	Pinal	2	ND		
		Santa Barbara	2	16	13	18
	11/21	Merced	2	32	14	49
		San Joaquin	2	140	15	265
		Stanislaus	2	84	64	104
	11/22	Mariposa	2	15	ND	30
		San Bernardino	4	ND		
		Stanislaus	2	13	12	13
	11/23	Los Angeles	2	ND		
		Maricopa	2	ND		
	11/25	Orange	2	ND		
	11/28	Madera	2	57	45	68
		Merced	2	ND		
		Stanislaus	4	35	7	97
	11/29	San Bernardino	2	ND		
		San Joaquin	2	2	ND	4
		Stanislaus	2	67	2	132
	12/1	Riverside	4	<1	ND	2
	12/2	Los Angeles	1	ND		
		Maricopa	2	ND		
		San Bernardino	1	160		
	12/5	Merced	5	72	54	105
		San Joaquin	1	34		
	12/6	San Joaquin	2	ND		
		Stanislaus	2	13	ND	25
	12/8	Los Angeles	5	ND		
		Maricopa	2	13	6	19
		San Bernardino	2	ND		
	12/13	Merced	3	3	ND	10
		San Joaquin	2	41	4	78
	12/14	Orange	2	ND		
	12/15	Maricopa	1	ND		
		San Bernardino	3	ND		
	12/16	Maricopa	3	ND		
		San Bernardino	3	ND		
	12/20	Los Angeles	5	<1	ND	3
		San Bernardino	5	ND		
	12/21	Sacramento	2	24	ND	47
	12/22	Monterey	3	12	ND	23
	12/23	Maricopa	2	ND		
	12/27	Merced	2	ND		
		San Joaquin	1	11		
	12/28	Riverside	5	ND		
		San Bernardino	2	ND		
	12/30	Maricopa	2	ND		
		San Bernardino	2	ND		
2 Northern California, Idaho, Nevada, Oregon, Utah, Washington, and Wyoming	7/6	Sanpete	1	87		
		Sevier	1	22		
		Utah	3	27	3	54
		Walla Walla	6	9	2	23
	7/7	Ada	1	ND		
		Canyon	1	ND		
		(Idaho) [f]	3	5	ND	14
	7/12	Sevier	2	24	3	44
		Utah	3	17	9	29
	7/13	Cache	1	54		
		Caribou	1	11		
		(Utah) [f]	2	15	6	24
	7/14	Bear Lake	1	66		
		Canyon	1	ND		
		Payette	1	9		
	7/15	Salt Lake	5	31	19	48
	7/18	Siskiyou	2	23	15	31
	7/21	Beaver	1	22		
		Iron	1	86		
		Millard	2	21	19	22
		Salt Lake	1	16		
		Summit	1	4		
		Utah	1	17		
		Washington	3	15	6	24
	7/27	Cache	1	7		
		Morgan	2	29	29	29
		Uinta	2	15	11	19
	7/28	Emery	1	15		
		Sevier	4	10	5	14
		Beaver	2	7	ND	13
	8/4	Garfield	1	4		
		Sanpete	1	7		
		Tooele	1	4		
	8/8	Ada	1	5		
		Gem	1	ND		
		(Idaho) [f]	4	1	ND	5
	8/9	Cache	1	3		
		Weber	6	5	ND	9

See footnotes at end of table.

Table 1. Iodine-131 in bovine thyroids, July–December 1966—Continued

Geographical grouping [a]	Date of slaughter	County of origin	Number of samples	pCi iodine-131/g thyroid		
				Average or concentration	Minimum	Maximum
2 Continued	8/10–11/9 [b]	[California] [c] Modoc (2) [c] Siskiyou (8) [Idaho] Ada (9) Adams (0) Bear Lake (0) Bingham (0) Caribou (0) Cassia (6) Canyon (40) Gem (0) Gooding (1) Madison (5) Oneida (4) Payette (0) Unknown (7) [Nevada] Elko (1) [Oregon] Baker (6) Harney (0) Malheur (10) Umatilla (1) Union (3) Wallowa (1) [Utah] Beaver (2) Box Elder (2) Cache (1) Davis (1) Duchesne (1) Emery (5) Garfield (0) Iron (0) Kane (2) Millard (5) Morgan (3) Rich (1) Salt Lake (5) Sanpete (1) Sevier (7) Summit (2) Tooele (0) Unknown (5) Utah (12) Wasatch (2) Washington (0) Wayne (1) Weber (32) [Washington] Walla Walla (49) [Wyoming] Uinta (0)	242	[d] ND		
	11/17	Baker	2	51	9	92
		Canyon	2	2	ND	3
		Harney	1	144		
		Madison	5	<1	ND	2
	11/18	Modoc	2	129	13	244
	11/23	Canyon	10	218	138	261
	11/25	Bingham	5	<1	ND	2
	11/28	Millard	1	ND		
		Salt Lake	4	152	4	279
	11/30	Millard	5	<1	ND	2
	12/1	Canyon	2	37	36	37
		Malheur	4	24	2	48
		(Oregon) [f]	4	58	26	105
	12/8	Sanpete	5	ND		
	12/14	Cassia	5	ND		
	12/16	Harney	10	38	ND	77
		Walla Walla	5	9	ND	25
	12/21	Canyon	7	ND		
	12/27	Siskiyou	2	ND		
	12/30	Adams	4	13	3	21
3 Northeastern Arizona, Colorado, New Mexico, & western Texas	7/1	Swisher	1	40		
	7/5	Bernalillo	4	14	4	22
	7/6	Curry	4	105	50	163
	7/11	Bernalillo	4	44	ND	98
	7/12	Curry	4	24	19	31
	7/18	Conejos	8	25	11	56
	7/25	Valencia	4	10	7	12
	7/26	Curry	4	8	2	10
	8/1	Conejos	4	3	ND	7
	8/2	Valencia	4	10	2	13
	8/8	Valencia	4	4	4	5
	8/9	Curry	4	3	ND	4
	8/15–11/9 [b]	[Arizona] [c] Apache (2) [c] Navajo (2) [Colorado] Conejos (0) Costilla (12) LaPlata (4) Mesa (1) [New Mexico] Bernalillo (12) Curry (16) Rio Arriba (0) San Miguel (4) Socorro (4) Valencia (28) [Texas] Castro (1) Swisher (0)	86	[d] ND		
	11/14	Valencia	4	41	7	60
	11/15	Conejos	4	19	ND	33
	11/21	Conejos	4	32	18	56
	11/22	Valencia	4	90	71	106
	11/28	Curry	4	51	14	89
	11/29	Bernalillo	3	27	21	34
		Rio Arriba	1	51		
	12/5	Valencia	4	22	4	39
	12/6	Valencia	4	30	9	48
	12/12	Valencia	4	16	6	29

See footnotes at end of table.

Table 1. Iodine-131 in bovine thyroids, July–December 1966—Continued

Geographical grouping [a]	Date of slaughter	County of origin	Number of samples	pCi iodine-131/g thyroid		
				Average or concentration	Minimum	Maximum
3 Continued	12/13	Bernalillo	1	ND		
		San Miguel	3	14	9	23
	12/19	Bernalillo	1	ND		
		Curry	3	4	2	6
	12/20	LaPlata	4	11	ND	18
	12/27	Valencia	4	5	ND	9
	12/28	Bernalillo	1	ND		
		LaPlata	3	3	ND	6
4 Kansas, Iowa, Minnesota, N. Dakota, S. Dakota, and Wisconsin	7/1	Brown	10	74	27	203
		Douglas (Kans)	1	29		
	7/6	Green	2	19	5	33
		Lyon (Kans)	2	23	21	25
	7/7	Dane	5	7	ND	19
	7/8	Sanborn	6	57	29	103
	7/11	Aurora	7	142	103	190
		Dane	2	6	4	7
	7/19	Brookings	1	7		
		Green	2	4	3	5
	7/20	Rock	6	13	ND	26
	7/22	Day	4	<1	ND	3
		Hanson	1	13		
	7/25	Lyon (Iowa)	4	29	10	54
	7/26	Lyon (Iowa)	5	27	16	35
	7/27	Dane	5	2	ND	9
		Lyon (Iowa)	1	18		
		Rock	2	ND		
	8/5	Aurora	6	17	10	23
		Green	2	5	3	6
	8/9	Aurora	10	11	5	17
	8/10	Dane	5	1	ND	6
	8/12–11/3 [b]	[Kansas] [c]	164	[d] ND		
		Douglas (0) [e]	Day (0)			
		Jefferson (0)	Douglas (0)			
		Leavenworth (0)	Grant (0)			
		Lyon (0)	Hand (0)			
		Morris (0)	Hanson (0)			
		Riley (0)	Jackson (0)			
		Shawnee (5)	Jones (0)			
		Wabaunsee (0)	Lake (2)			
		[Iowa]	Lyman (10)			
		Lyon (0)	Mellette (0)			
		[Minnesota]	Miner (4)			
		Lincoln (0)	Sanborn (0)			
		[North Dakota]	Sully (0)			
		Dickey (8)	Tripp (10)			
		[South Dakota]	Turner (4)			
		Aurora (13)	[Wisconsin]			
		Brookings (0)	Dane (25)			
		Brown (15)	Green (8)			
		Davidson (10)	Rock (40)			
	11/10	Rock	7	6	ND	16
	11/14	Aurora	2	21	ND	42
		Dane	2	7	ND	14
		Jackson	1	ND		
		Lyman	1	ND		
		Mellette	2	15	ND	29
		(South Dakota) [f]	5	2	ND	10
	11/18	Jones	9	ND		
	11/22	Green	4	9	ND	26
		Rock	3	7	ND	17
	11/29	Rock	9	1	ND	6
	11/30	Lyman	5	ND		
		(South Dakota) [f]	3	ND		
	12/1	Jefferson	1	51		
	12/2	Green	2	19	14	23
	12/6	Lincoln	1	ND		
		Mellette	2	65	51	78
	12/7	Lincoln	7	4	ND	10
	12/8	Riley	1	17		
	12/9	Dane	3	ND		
		Shawnee	1	7		
	12/12	Douglas (Kans)	1	32		
	12/14	Rock	5	4	ND	9
	12/15	Douglas (Kans)	1	34		
		Hand	9	ND		
		Lyon (Kans)	2	ND		
	12/16	Morris	1	ND		
	12/20	Leavenworth	1	ND		
	12/21	Mellette	10	6	ND	13
		Rock	4	ND		
	12/27	Dane	2	ND		
	12/29	Douglas (S. Dak)	5	2	ND	5
		Sully	4	3	ND	4
	12/30	Wabaunsee	2	24	18	30

See footnotes at end of table.

Table 1. Iodine-131 in bovine thyroids, July–December 1966—Continued

Geographical grouping [a]	Date of slaughter	County of origin	Number of samples	pCi iodine-131/g thyroid		
				Average or concentration	Minimum	Maximum
5 Mississippi, Louisiana, Oklahoma, and Eastern Texas	7/1	Denton	1	76		
		Tarrant	1	68		
	7/5	Marion	5	29	10	49
	7/20	Hunt	1	11		
	7/27	Hunt	1	12		
	7/28	McCurtain	2	7	5	9
	8/2	Lauderdale	5	3	ND	5
	8/8	Forrest	5	2	ND	6
	8/16–11/1 [b]	[Mississippi] [c]	75	[d] ND		
		Forest (15) [e]	Fanin (1)			
		Jones (10)	Harrison (2)			
		Lauderdale (9)	Hood (1)			
		Yazoo (5)	Hunt (2)			
		[Louisiana]	Johnson (1)			
		Bossier (2)	Karnes (2)			
		Claiborne (3)	Navarro (0)			
		Natchitoches (1)	Panola (1)			
		[Oklahoma]	Red River (3)			
		Jefferson (1)	Smith (3)			
		McCurtain (1)	Stephens (0)			
		[Texas]	Tarrant (0)			
		Bowie (1)	Titus (3)			
		Collin (1)	Unknown (1)			
		Dentin (0)	Wichita (0)			
		Ellis (3)	Wood (3)			
	11/9	Navarro	2	73	5	141
	11/11	Tarrant	1	114		
	11/17	Titus	4	86	13	166
	11/18	Wichita	1	204		
	11/22	Stephens	2	83	64	101
	12/9	Ellis	2	48	34	62
	12/21	Tarrant	2	8	5	10
6 Georgia, North Carolina, South Carolina, and Tennessee	7/6	Blount	2	47	36	58
		Candler	3	8	2	19
		Carroll	1	27		
		Knox	2	29	15	43
		Loudon	1	86		
	7/7	Clarke	3	59	39	78
	7/8	Clarke	1	24		
		Washington	1	44		
	7/11	Spartanburg	1	9		
		Washington	1	28		
	7/12	Grainger	1	34		
		Knox	3	41	26	53
		Sevier	2	44	39	48
	7/13	Bibb	2	17	9	24
		Columbia	1	31		
		Laurens	3	24	22	25
	7/18	Sumter	1	ND		
	7/19	Sumter	2	ND		
	7/20	Bamberg	6	13	6	21
		Blount	2	16	14	17
		Knox	2	9	6	11
		Laurens	2	10	7	13
		Sevier	1	21		
	7/25	Bartow	5	7	3	10
	7/26	Forsyth	1	12		
		Orangeburg	4	7	4	12
	8/1	Burke	1	ND		
		Screven	1	ND		
	8/2	Blount	1	ND		
		Fentress	1	2		
		Grainger	2	7	6	7
		Greenwood	1	2		
		Knox	1	2		
		Lincoln	1	ND		
		McCormick	1	6		
		Screven	1	ND		
	8/3	Greene	1	2		
		Saluda	2	8	7	9
		Warren	1	ND		
	8/9	Blount	3	4	2	6
		Grainger	1	3		
		Knox	1	ND		
		Sevier	1	ND		
	8/10–8/16 [b]	[Georgia] [c]	21	[d] ND		
		Laurens (5) [e]	[South Carolina]			
		McDuffie (4)	Bamberg (1)			
		Monroe (5)	[Tennessee]			
			Blount (5)			
			Grainger (1)			

See footnotes at end of table.

Table 1. Iodine-131 in bovine thyroids, July–December 1966—Continued

Geographical grouping [a]	Date of slaughter	County of origin	Number of samples	pCi iodine-131/g thyroid		
				Average or concentration	Minimum	Maximum
6 Continued	8/23	Forsyth	1	139		
		Monroe (Ga)	1	ND		
		Orangeburg	2	25	16	33
	8/24	Blount	2	3	2	3
		Grainger	1	4		
		Jefferson	1	3		
		Knox	2	3	2	3
	8/25–11/1 [b]	[Georgia] [c]	151	[d] ND		
		Bartow (0) [c]				
		Bibb (9)				
		Burke (3)				
		Candler (3)				
		Carroll (0)				
		Cherokee (2)				
		Clarke (0)				
		Cloumbia (0)				
		Emanual (1)				
		Forsyth (0)				
		Fulton (1)				
		Gorden (1)				
		Greene (6)				
		Hancock (1)				
		Jenkins (2)				
		Laurens (0)				
		Lincoln (0)				
		McDuffie (1)				
		Monroe (1)				
		Richmond (0)				
		Screven (7)				
		Sumter (0)				
		Tattnell (2)				
		Toombs (0)				
		Upson (4)				
		Warren (7)				
		Wilkes (8)				
		[North Carolina]				
		Cleveland (2)				
		[South Carolina]				
		Aiken (4)				
		Bamberg (3)				
		Barnwell (2)				
		Edgefield (2)				
		Greenwood (5)				
		Lexington (5)				
		McCormick (3)				
		Orangeburg (0)				
		Saluda (11)				
		Spartanburg (6)				
		[Tennessee]				
		Blount (23)				
		Fentress (0)				
		Grainger (1)				
		Jefferson (0)				
		Knox (12)				
		Loudon (1)				
		Monroe (4)				
		Sevier (6)				
		Roane (1)				
		Unknown (1)				
	11/8	Blount	1	53		
		Grainger	1	ND		
		Knox	2	89	68	109
		Laurens	3	ND		
		Sevier	2	60	15	104
		Tattnell	1	ND		
		Upson	4	1	ND	2
		Washington	2	1	ND	2
	11/14	Blount	1	52		
	11/15	Blount	2	43	15	71
		Cleveland	2	90	66	113
		Greenwood	1	123		
		McCormick	1	125		
		Roane	1	44		
		Toombs	3	34	10	79
		Warren	2	107	74	139
		Wilkes	1	117		
	11/21	Cleveland	1	8		
		Columbia	1	4		
		Greene	2	8	4	11
		Greenwood	1	8		
		Saluda	3	12	4	21
		Screven	1	8		
		Warren	1	14		
	11/22	Blount	1	78		
		Jefferson	1	158		
		Knox	2	67	37	97
		Loudon	2	82	66	97
	11/28	Blount	2	87	68	106
		Monroe (Tenn)	1	149		
		Screven	2	9	7	10
		Sevier	2	30	2	57
	11/29	Columbia	1	11		
		Greenwood	1	35		
		Lexington	1	23		
		Richmond	1	18		
		Saluda	2	6	5	6
		Wilkes	2	26	13	38
	12/5	Spartanburg	10	6	2	11
	12/6	Blount	6	89	5	124
	12/13	Aiken	1	5		
		Cleveland	2	7	5	9
		Columbia	1	2		
		Greene	1	4		
		Greenwood	1	7		
		Saluda	2	3	2	4
		Screven	1	6		
	12/13	Warren	1	3		
	12/14	Blount	5	30	7	62
		Knox	1	55		

See footnotes at end of table.

Table 1. Iodine-131 in bovine thyroids, July–December 1966—Continued

Geographical grouping [a]	Date of slaughter	County of origin	Number of samples	pCi iodine-131/g thyroid		
				Average or concentration	Minimum	Maximum
6 Continued	12/20	Aiken	1	ND		
		Barnwell	1	ND		
		Blount	4	15	11	18
		Burke	2	ND		
	12/20	Columbia	1	ND		
		Greene	2	ND		
		Greenwood	1	ND		
		Saluda	1	ND		
		Sevier	2	17	9	25
		Wilkes	1	ND		
	12/28	Barnwell	1	ND		
		Blount	2	6	2	9
		Cleveland	2	ND		
		Hancock	1	ND		
		Jefferson	1	10		
		McCormick	1	ND		
		Monroe (Tenn)	2	ND		
		Saluda	3	ND		
		Wilkes	2	ND		
7 New York and Vermont	7/6	Chautauqua	10	12	2	31
	7/7	Cattaraugus	1	41		
	7/11	Franklin	9	9	ND	17
	7/12	Franklin	10	ND		
	7/13	Chautauque	10	7	2	13
	7/15	Cattaraugus	7	9	5	13
	7/20	Chataugua	10	2	ND	7
	7/21	Cattaraugus	4	5	2	7
	7/27	Chautauqua	10	2	ND	4
		Franklin	10	ND		
	7/28	Cattaraugus	4	2	ND	4
	8/2	Franklin	6	3	ND	6
	8/4	Cattaraugus	1	ND		
		Chautauqua	10	2	ND	6
	8/10	Chautauqua	10	2	ND	6
	8/11–11/14 [b]	[New York] [c] Cattaraugus (23) [e] [Vermont] Chautauqua (126) Franklin (84)	233	[d] ND		
	11/16	Chautauqua	10	29	ND	191
	11/23	Chautauqua	10	10	ND	58
	11/28	Franklin	10	ND		
	11/30	Chautauqua	10	7	ND	53
	12/7	Chautauqua	10	5	ND	23
	12/14	Chautauqua	9	ND		
		Franklin	10	ND		
	12/21	Chautauqua	11	1	ND	15
	12/28	Franklin	10	ND		

[a] Geographical areas (designated in figure 1) encompass counties that were sampled in the States indicated.
[b] Samples were not collected on all dates during this period, but the interval includes several sampling dates.
[c] Brackets give State and are followed by counties sampled during the period indicated or on some other date during July-December 1966.
[d] The results for this period were for the most part not detectable. Some positive results were obtained, but represented barely detectable amounts of iodine-131 in the bovine thyroid. In general, these positive results were 2–5 pCi/g thyroid and randomly scattered over the time period and counties indicated.
[e] Numbers in parentheses represent the number of samples collected from each county during the interval indicated. These may have been collected over several dates during the period or on only one date. (0) indicates that the county was not sampled during the interval given but was sampled on another date during July-December 1966. (Unknown) refers to a sample collected in an unspecified county.
[f] The exact county is unknown.
ND, not detectable; the two standard deviation counting error was greater than or equal to the concentration observed. For the counting system utilized and these very low concentrations the two standard deviation counting errors were generally 1–3 pCi/g thyroid.

The results for July through December 1966 appear in table 1 and are listed chronologically within the geographical groupings delineated in figure 1. The influx of fallout iodine-131 following the mainland China atmospheric nuclear detonation of May 9, 1966, which was observed during the early and middle part of June 1966 (*2*), declined to barely detectable levels in early August 1966. The influx of fallout iodine-131 following the subsequent Chinese test of October 27, 1966, EST., was observed through November and December 1966, with peak values for individual specimens in the various geographical groupings ranging from 80 to 280 pCi/g thyroid during the latter part of November and early part of December 1966. Over the period August 23-24, iodine-131 was detected in isolated samples collected from one county in Georgia and one county in South Carolina.

REFERENCES

(*1*) BARATTA, E. J., E. R. WILLIAMS, and G. MURRAY. Iodine–131 in bovine thyroid, October-December 1964. Radiol Health Data 6:569–574 (October 1965).

(*2*) PUBLIC HEALTH SERVICE, NATIONAL CENTER FOR RADIOLOGICAL HEALTH. Iodine–131 in bovine thyroids, January–June 1966. Radiol Health Data Rep 8:51–55 (January 1967).

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The U.S. Atomic Energy Commission (AEC) receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major AEC installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual."[1]

Summaries of the environmental radioactivity data follow for the Bettis Atomic Power Laboratory, Feed Materials Production Center, Knolls Atomic Power Laboratory, and the S1C Prototype Reactor Facility.

[1] Title 10, Code of Federal Regulations, Part 20 "Standards for Protection Against Radiation," Appendix B, Note 3.C, contains the applicable AEC standard.

1. Bettis Atomic Power Laboratory January-June 1966[2]

Westinghouse Electric Corporation
Pittsburgh, Pennsylvania

The Bettis Atomic Power Laboratory (BAPL), operated for the Atomic Energy Commission by the Westinghouse Electric Corporation, was established in 1949 to conduct research and development operations related to naval atomic propulsion systems and to the central station power reactor at Shippingport, Pennsylvania. Routine environmental monitoring data from the sampling locations shown in figure 1 show no significant contribution from laboratory operations to environmental radioactivity levels.

Liquid radioactive waste

Liquid effluent discharged from the laboratory is sampled continuously. Composite samples are analyzed weekly for gross alpha and gross beta-gamma radioactivity, and quarterly for strontium-90 activity.

The average concentration of gross beta radioactivity in the main laboratory liquid effluent during the first 6 months of 1966 was 140 pCi/liter. This was lower than the average concentration of 650 pCi/liter observed in the second half of 1965. The maximum and minimum gross beta radioactivity detected in the weekly samples amounted to concentrations of 590 pCi/liter and 20 pCi/liter, respectively.

The average concentration of gross alpha-particle activity in the main laboratory effluent was 7.4 pCi/liter, a reduction from the 11 pCi/liter average for the previous 6-month period. The maximum gross alpha-particle activity detected in weekly samples during this period was 16 pCi/liter while the minimum was 0.79 pCi/liter.

The average concentration of strontium-90 in liquid waste was 3.9 pCi/liter, versus 20 pCi/liter for the second 6 months of 1965.

Average radioactivity concentrations in liquid waste effluent from the critical facility operations during the first half of 1966 were: alpha radioactivity, <68 pCi/liter; beta-gamma radioactivity, 1.3×10^3 pCi/liter. Comparable values for the last half of 1965 were <68 pCi/liter for alpha radioactivity, and 1.5×10^3 pCi/liter for beta-gamma radioactivity.

Background monitoring stations

Beta-gamma background radiation levels were continuously monitored and recorded at 34 film badge monitoring stations located at 100-yard intervals along the boundary of the laboratory property which lies within the controlled confines of the Bettis Atomic Power Laboratory site.

[2] Summarized from "Environmental Radioactivity at the Bettis Atomic Power Laboratory for the First 6 Months of 1966" (PNR-DEV-138).

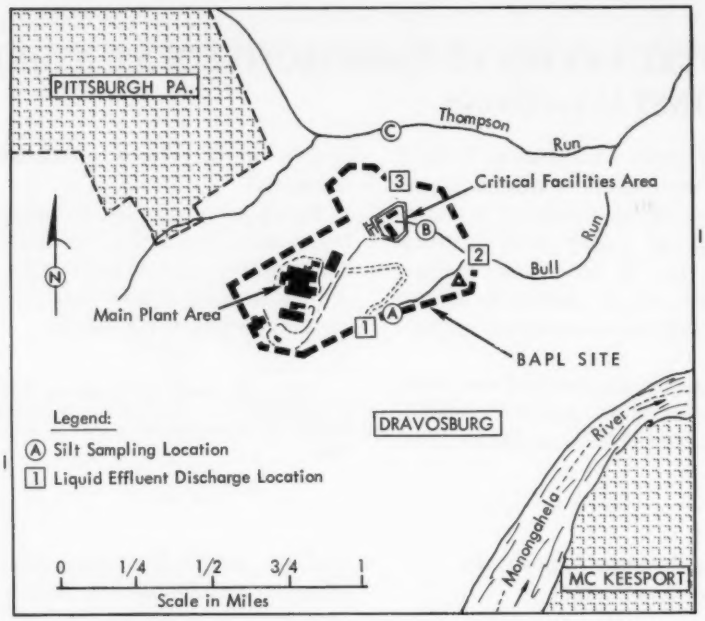

Figure 1. Bettis Atomic Power Laboratory sampling stations

The average beta-gamma background radiation level during the first half of 1966 was 0.067 mR/hr for the main laboratory area, and 0.028 mR/hr for the critical facility area. The respective average exposure values for the period from November 11 (when film badge monitoring began) through December 31, 1965, were 0.034 mR/hr and 0.020 mR/hr. Table 1 summarizes results obtained during the first half of 1966 from the background-monitoring stations.

Table 1. Beta-gamma background radiation monitoring, Bettis, January–June 1966

Location	January–June 1966 average exposure rate (mR/hr)
Main laboratory area	
Maximum of 20 locations	0.315
Minimum of 20 locations	0.005
20 locations	0.067
Critical facility area	
Maximum of 14 locations	0.072
Minimum of 14 locations	0.006
14 locations	0.028
BAPL	
34 locations	0.051

Stream silt

Stream silt samples were collected quarterly at the three locations shown in figure 1. The results of analysis of these samples are presented in table 2. The average alpha and beta-gamma radioactivity concentrations of stream silt samples were 0.65 pCi/g and 22 pCi/g, respectively, for the first half of 1966. Both of these values are considerably lower than their respective values of 27 pCi/g and 230 pCi/g reported during the last half of 1965. These decreases were likely a result of lower alpha and beta-gamma radioactivity concentrations in the main laboratory and critical facility liquid effluents discharged during the first 6 months of 1966.

Table 2. Radioactivity in stream silt, Bettis January–June 1966

Period 1966	Location *	Silt radioactivity (pCi/g)	
		Alpha	Beta-gamma
January–March	A	0.25	74
	B	0.25	16
	C	0.095	14
	Average	0.20	35
April–June	A	0.71	4.4
	B	1.3	12
	C	1.4	12
	Average	1.1	9.5
January–June	Average	0.65	22

* See figure 1 for locations.

Semiannual gamma spectra and analyses for strontium-89 and strontium-90 were obtained for composites of quarterly silt samples. Table 3 presents the results of these analyses for samples collected during the second half of 1965. Gamma spectra and analytical results for strontium-89 and strontium-90 for the samples obtained during the first half of 1966 are not yet available and will be included in the report for the second half of 1966.

Table 3. Gamma-emitting radionuclides, strontium-89, and strontium-90 in stream silt (6-month composite), Bettis, July–December 1965

Location *	Identified gamma emitters	Concentration (pCi/g of silt)	
		Strontium-89	Strontium-90
A	Potassium-40, and daughters of radium-226.	0.036	0.37
B	Zirconium-95, niobium-95, and cobalt-60.	0.027	0.63
C	Potassium-40, and daughters of radium-226.	0.045	0.12

* See figure 1 for locations.

Recent coverage in *Radiological Health Data and Reports*:

Period	Issue
January–June 1965	April 1966
July–December 1965	October 1966

2. Feed Materials Production Center January-June 1966[3]

National Lead Company
Fernald, Ohio

The Feed Materials Production Center (FMPC) is operated by the National Lead Company of Ohio for the AEC. The location as related to populated areas is shown in figure 2. Cincinnati and Hamilton—the larger nearby communities—are situated 20 and 10 miles, respectively, from the Center. FMPC processes high-grade uranium ores and ore concentrates to produce metallic uranium, and fabricates the metal into fuel elements.

[3] Summarized from "Feed Materials Production Center Environmental Monitoring Semi-Annual Report for the First Half of 1966" (NLCO–981).

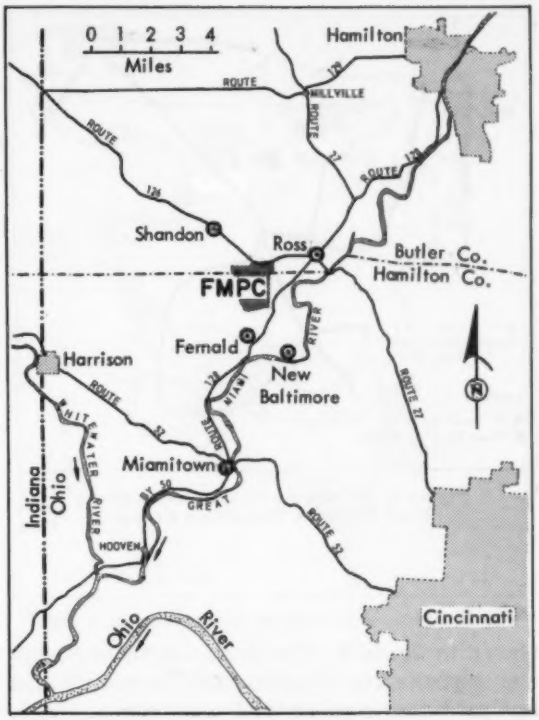

Figure 2. Area map of Feed Materials Production Center

An environmental survey program has been established to detect radioactive contaminants of FMPC origin and to evaluate their impact on the surrounding environs. The results of this program, both present and past, indicate that the material released to the environs at this site is below the maximum permissible concentrations (MPC) as recommended by the National Committee on Radiation Protection and Measurements (NCRP) and the State of Ohio.

Air monitoring

Many of the processes at FMPC generate airborne dusts. Specially designed equipment is used to recover particulates released to the air by these processes and to control release of radioactive particulates through the exhaust stacks.

Onsite air samples are obtained from four permanent perimeter air sampling stations, located at the four corners of the production area,

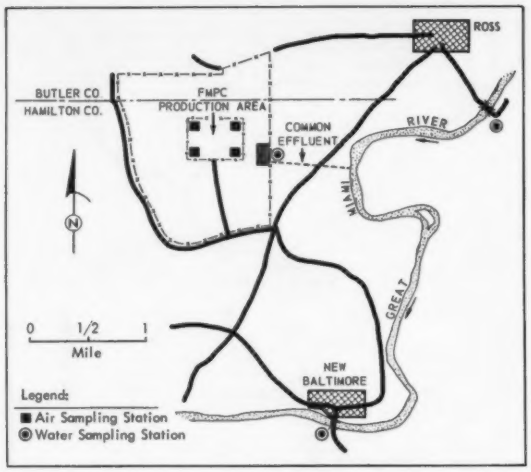

Figure 3. Air and water sampling stations Feed Materials Production Center

shown in figure 3. Samples from these perimeter stations are collected once each week and analyzed for uranium and total radioactivity. Offsite samples are collected by a mobile air sampling unit. The location at which samples are collected is determined by local meteorological conditions on the day of sampling. Approximately 20 percent of all samples are taken upwind of the FMPC plant. Replicate samples are taken at each sampling point and averaged to obtain a representative concentration for that location. Concentrations of uranium and total radioactivity of airborne particulates sampled at onsite and offsite locations are given in table 4.

Water monitoring

Each of the individual production plants on the project has collection sumps and treatment equipment to remove the uranium from the process waste water. The effluent from the plants are collected at a general sump for equalization and settling. The clear water from the sump is pumped to the river. The solid portion is pumped to a chemical waste pit for further settling. The flow, which is decanted to the clear-well portion of the pit, is virtually free of solids and radioactivity. The effluent from the sump and clear-well are combined with waste water from the FMPC water treatment plant, sanitary sewage treatment plant, and storm sewerage system and discharged via a common effluent outfall into the Great Miami River. A weir type of water sampler collects samples of the combined effluent stream, which are removed and analyzed daily. These results and measurements of river flow are used in calculating the radioactive contaminant concentrations added to the river. Weekly spot samples are also obtained upstream and downstream from the common FMPC effluent at locations shown in figure 3. The results of the FMPC water monitoring program for the first half of 1966 are summarized in table 5.

Table 4. Radioactivity levels of airborne particulates, FMPC, January–June 1966

Location	Number of samples	Uranium concentration [a] (pCi/m³)			Total radioactivity [b] (pCi/m³)		
		Maximum	Minimum	Average	Maximum	Minimum	Average
Onsite:							
Southwest	25	1.3	<0.1	0.2	2.3	<0.1	0.4
Northwest	25	.2	< .1	.1	.3	< .1	.2
Northeast	25	.3	< .1	.1	1.0	< .1	.3
Southeast	25	.4	< .1	.1	.9	< .1	.2
All onsite samples	100	1.3	< .1	.1	2.3	< .1	.3
Offsite:							
0–2 miles from FMPC	26	0.5	< .1	< .1	1.1	.1	.3
2–4 miles from FMPC	40	.1	< .1	< .1	.5	.1	.2
4–8 miles from FMPC	32	.3	< .1	< .1	1.0	.1	.2
8–12 miles from FMPC	5	< .1	< .1	< .1	.1	.1	.1
All offsite samples	103	.5	< .1	< .1	1.1	.1	.2

[a] AEC radiation protection standard, 2 pCi/m³
[b] AEC radiation protection standard, 100 pCi/m³

Table 5. Radioactivity in the Great Miami River, FMPC, January–June 1966

Location	Number of samples	Uranium concentration [a] (pCi/liter)			Total radioactivity [b] (pCi/liter)		
		Maximum	Minimum	Average	Maximum	Minimum	Average
Sewer outfall	181	90	<10	2	140	<10	10
Upstream from outfall	26	20	<10	5	90	<10	30
Downstream from outfall	28	20	<10	6	140	<10	30

[a] AEC radiation protection standard, 20,000 pCi/liter
[b] AEC radiation protection standard, 3,000 pCi/liter

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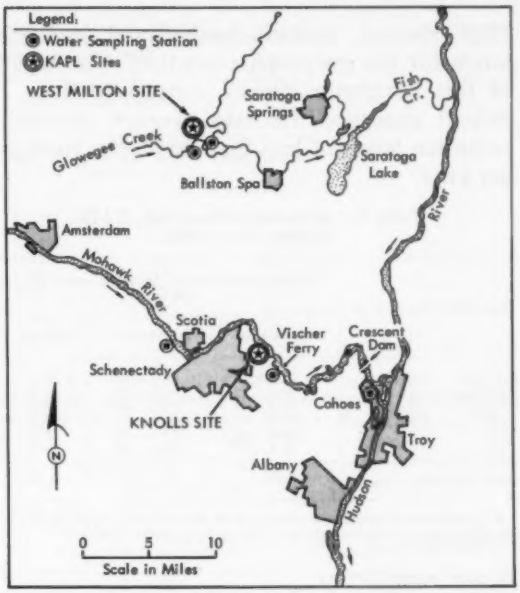

Figure 4. Environmental monitoring locations, KAPL

3. Knolls Atomic Power Laboratory January-June 1966[4]

General Electric Company
Schenectady, New York

The principal function of the Knolls Atomic Power Laboratory (KAPL), operated by the General Electric Company for the Atomic Energy Commission, is to support the Naval Reactors Program of the AEC in the development of atomic power for naval propulsion. This includes design, construction, and prototype operation of nuclear power reactors.

The Knolls Atomic Power Laboratory consists of two sites, the Knolls site and the West Milton site (figure 4). The Knolls site occupies approximately 170 acres on which are located administrative buildings; chemistry, physics, metallurgical, engineering, and radioactive materials laboratories; critical assembly buildings; machine shops, decontamination facilities; radioactive waste storage and processing facilities; and nuclear fuel storage and assembly buildings. The West Milton site occupies approximately 4,000 acres. Its principal facilities include the Triton (S3G) and Bainbridge (D1G), prototype reactors, equipment service building, fuel service building, and waste treatment facilities. Regular environmental monitoring activities are conducted to assure that laboratory releases of radioactivity to the environment are in compliance with AEC standards.

[4] Summarized from "Knolls Atomic Power Laboratory, Semiannual Environmental Monitoring Report, January–June 1966."

Air monitoring

Environmental airborne radioactivity is measured at two locations on the Knolls site, four locations at the West Milton site, and at the General Electric Company Research Laboratory approximately 1 mile west of the Knolls site. Airborne radioactivity is sampled continuously and analyzed on a weekly basis. Each environmental monitoring station is equipped with film dosimeters to detect integrated gamma radioactivity levels. The average airborne beta and gamma radioactivity at each of the three areas is summarized in table 6 for the 6-month period.

In addition to the environmental airborne radioactivity monitoring, surveys are made semiannually of the radiation levels at the perimeter of KAPL at both the West Milton and Knolls sites. The perimeter survey of June

1966 showed normal background radiation levels for the geographic location. The results of this perimeter survey, extrapolated to an annual exposure, indicate average perimeter radiation levels of less than one-tenth roentgen per year.

Table 6. Airborne radioactivity, KAPL, January–June 1966

Sampling period 1966	Average radioactivity (beta + gamma) in air [a] (pCi/m³)		
	Knolls site	West Milton	Offsite
January	0.07 ±0.01 [b]	0.06 ±0.02 [b]	0.05 ±0.01 [b]
February	.05 ± .01	.03 ± .02	.07 ± .01
March	.07 ± .01	.08 ± .02	.07 ± .01
April	.07 ± .01	.09 ± .02	.07 ± .01
May	.10 ± .01	.15 ± .02	.10 ± .01
June	.19 ± .01	.24 ± .02	.21 ± .01
January–June	0.09	0.11	0.09

[a] Samples are counted a minimum of 48 hours after collection to allow short-lived natural radionuclides to decay to nondetectable levels.
[b] Counting error.

Water monitoring

All potential sources of liquid radioactive waste at the Knolls site are connected by control drains to collection tanks in the radioactive waste-processing building. The release of liquid waste to the Mohawk River is regulated through the monitoring of the concentration of fission products in the collection tanks and the control of the discharge rate of the effluent.

A continuous proportional sample of the Knolls site combined-sewer effluent is taken at the point of discharge to the Mohawk River. Radiochemical analyses of the weekly composite samples show that strontium-90 is the principal radionuclide to be considered in control. The amounts and the radionuclide content of the combined sewer effluent discharged from the Knolls site are summarized in tables 7 and 8.

Mohawk River water is sampled continuously at the point of discharge from the Knolls site;

Table 7. Radioactivity (beta + gamma) in the Knolls site liquid waste effluent, January–June 1966

Sampling period 1966	Total radioactivity (millicuries)	Average concentration [a] (pCi/liter)
January	25.3	1.7×10^{2}
February	13.3	1.3×10^{2}
March	22.0	2.8×10^{2}
April	35.8	5.0×10^{2}
May	18.1	1.5×10^{2}
June	10.1	0.9×10^{2}
January–June	124.6	2.0×10^{2}

[a] Average concentration for the first half of 1966 represents a weighted average of the weekly composite samples collected during the period.

Table 8. Concentration of specific radionuclides in the Knolls site liquid waste effluent, January–June 1966

Radionuclide	Average radionuclide concentration (pCi/liter)	Applicable AEC standard [a]
Cerium-praseodymium-144	13	10,000
Cesium-137	38	20,000
Iodine-131	<2	300
Ruthenium-106	<2	10,000
Strontium-89	<2	3,000
Strontium-90	69	300
Yttrium-90	68	20,000

[a] AEC manual, chapter 0524 "Standards for Radiation Protection" Appendix annex 1 contains the applicable AEC standards.

at the General Electric Company powerhouse 8 miles upstream from the site; at the Vischer Ferry powerhouse approximately 2 miles downstream; and at the City of Cohoes pumping station about 13 miles downstream. Results of this sampling along with those for precipitation are given in table 9.

The Knolls site effluent is sampled continuously for alpha-particle activity. During the first half of 1966 the semiannual discharge rate of alpha-particle emitters was less than 1 percent of the most restrictive AEC radiation protection standards for an alpha-particle emitting radionuclide (5×10^{3} pCi/liter for plutonium-239). The radioactivity levels in the liquid waste from the West Milton site are operationally controlled and diluted prior to release into Glowegee Creek. Samples of the creek water are taken once a week at two locations: one is about 150 feet above the point where the S3G effluent enters the creek and the other is about 2,640 feet below the S3G discharge, or 1,500 feet below the D1G discharge. Table 10 presents a summary of radioactive wastes discharged to Glowegee Creek in terms of total radioactivity and concentration in liquid wastes.

Radiochemical analyses of these wastes indicated that strontium-89 and strontium-90 concentrations were less than 2 percent of the respective AEC standards during the reporting period. The average results for unidentified radionuclides in the D1G and S3G effluents (43 and 84 pCi/liter respectively) represent less than 2 percent and less than 3 percent of the applicable AEC radiation protection standard of 3×10^{3} pCi/liter.[5]

[5] AEC Manual, Chapter 0524 "Standards for Radiation Protection," Appendix Annex 1, Note 3.C, contains the applicable AEC standard.

Table 9 Radioactivity in Mohawk River water and precipitation near the Knolls site, January–June 1966

Sampling period 1966	Average radioactivity (beta + gamma) (pCi/liter)			
	G.E. powerhouse (upstream)	Vischer Ferry (downstream)	Cohoes raw water (downstream)	Precipitation
January	5 ±4[a]	3 ±4[a]	6 ±4[a]	0.2×10^{3}
February	5 ±4	4 ±4	3 ±4	0.3×10^{3}
March	4 ±4	3 ±4	3 ±4	0.3×10^{3}
April	5 ±4	1 ±4	1 ±4	0.3×10^{3}
May	6 ±4	4 ±4	4 ±4	9.2×10^{3}
June	5 ±4	5 ±4	7 ±4	2.0×10^{3}
January–June	5	3	4	2.1×10^{3}

[a] Counting error

Table 10. Radioactivity (beta + gamma) in West Milton liquid waste effluents, KAPL, January–June 1966

Sampling period 1966	Total radioactivity (millicuries)		Average radioactivity (pCi/liter)	
	D1G effluent	S3G effluent	D1G effluent	S3G effluent
January	0.39	0.05	37	24
February	.47	.08	39	36
March	.61	.33	47	118
April	.69	.23	47	105
May	1.40	.39	69	154
June	.66	.14	26	78
January–June	4.22	1.22	44	86

Table 11 presents the average concentrations of beta-particle and gamma-ray activity detected in Glowegee Creek water upstream and downstream from the S3G and D1G liquid waste outfalls and in precipitation collected during this period.

Table 11. Radioactivity in Glowegee Creek water and precipitation near the West Milton site, KAPL, January–June 1966

Sampling period 1966	Average radioactivity (beta + gamma) (pCi/liter)		
	Glowegee Creek (upstream)	Glowegee Creek (downstream)	Precipitation
January	4 ±7[a]	12 ±7[a]	0.4×10^{3}
February	9 ±7	2 ±7	0.2×10^{3}
March	9 ±7	12 ±7	1.1×10^{3}
April	10 ±7	7 ±7	1.5×10^{3}
May	12 ±7	2 ±7	1.6×10^{3}
June	14 ±7	15 ±7	2.8×10^{3}
January–June	10	8	1.3×10^{3}

[a] Counting error

Recent coverage in *Radiological Health Data and Reports*:

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4. S1C Prototype Reactor Facility January-June 1966[6]

Combustion Engineering, Inc.
Windsor, Connecticut

The S1C Prototype Reactor Facility is a land-based nuclear submarine power plant operated for the Atomic Energy Commission by the Naval Reactors Division of Combustion Engineering, Inc. The prototype contains a pressurized water reactor power plant which is used to conduct research and development work and to train personnel in the operation of naval reactor power plants. Reactor power operations at the S1C Prototype Facility began in December 1959.

The low-level radioactive waste discharged intermittently from S1C prototype operations consists mainly of water. Small quantities of airborne particulates in gaseous waste are also generated and released on occasion in the ventilation exhaust air.

Essentially, all of the radioactive waste originates from the activation of minute amounts of impurities or corrosion products in the circulating water used as a reactor coolant. All materials released to the environment are routinely monitored to assure that waste disposal operations comply with AEC regulations.

[6] Summarized from "S1C Prototype Reactor Facility Environmental Monitoring Report, January 1 through June 30, 1966" (CENRD–3163–RS–544).

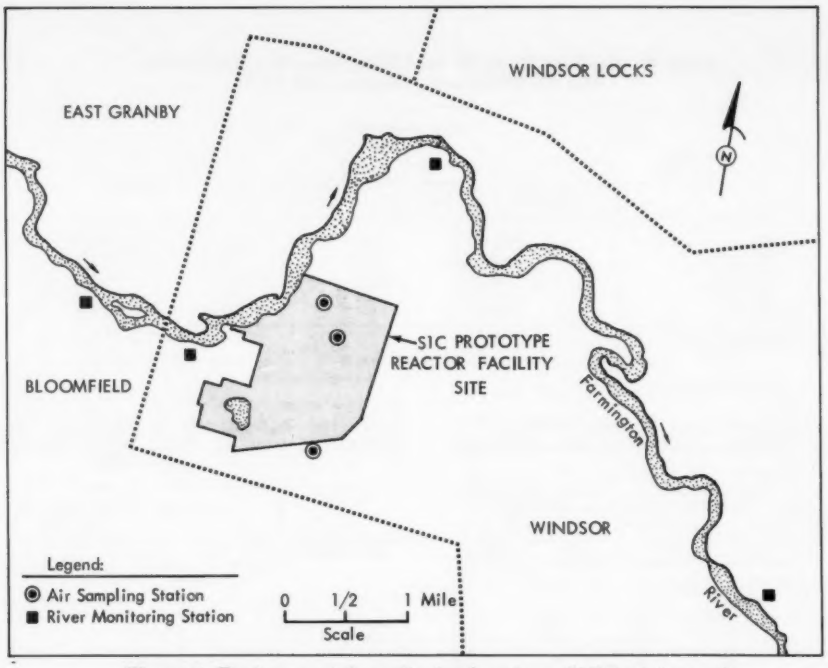

Figure 5. Environmental monitoring locations, S1C Prototype site

Air monitoring

Ventilation air from the submarine hull and the supporting facility at the prototype site may contain small amounts of radioactive gases or particulates. This ventilation air is discharged to the environment through an exhaust stack. The ventilation air is continuously monitored for radioactivity by automated counters which control the discharge of the exhaust air. When the AEC maximum permissible concentration limits are exceeded, the exhaust air is discharged through a high-efficiency filter bank or the ventilation system is completely shut down and the hull sealed. In addition, air is continuously sampled for particulates at onsite and offsite locations shown in figure 5. Table 12 presents the average gross beta-particle activity concentrations detected at air-monitoring stations during the first and second quarters of 1966.

Water monitoring

Liquid wastes are collected in 5,000-gallon retention tanks. If the radioactivity in a filled tank is below the allowable AEC limit for discharge to uncontrolled areas, the tank contents are released into the industrial waste system. If the limit is exceeded, the contents are diluted below the applicable AEC radiation protection standard in a 25,000-gallon dilution tank and then released. Table 13 is a summary of the gross beta-particle activity released to the Farmington River during the first half of 1966.

Table 12. Gross beta-particle activity in continuous air samples S1C, January–June 1966

Sampling location	Beta radioactivity concentration (pCi/m^3)					
	January–March			April–June		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Stack and hull exhausts	36	75	58	28	92	60
Onsite stations	0.12	2.1	0.40	0.11	5.5	0.25
Offsite stations	0.11	3.0	0.30	0.12	0.65	0.20

Table 13. Gross beta-particle activity released to the Farmington River, S1C, January–June 1966

Period	Total radioactivity (millicuries)	Average concentration (pCi/liter)
January–March	1.16	4.8×10^3
April–June	9.24	3.3×10^3

The concentrations of specific radionuclides released to the river during this period are presented in table 14.

Table 14. Concentration of specific radionuclides released to the Farmington River, S1C, January–June 1966

Radionuclide	Average concentration for Jan–June 1966 (pCi/liter)	Applicable AEC Standard [a] (pCi/liter)
Cobalt-60	3.5×10^{3}	3×10^{4}
Iron-59	5.2×10^{3}	5×10^{4}
Manganese-54, cobalt-58	4.1×10^{3}	9×10^{4}

[a] AEC manual, Chapter 0524, "Standards for Radiation Protection" Appendix Annex 1, contains the applicable AEC standard.

The Farmington River is sampled periodically at various locations as shown in figure 5 for determination of gross beta-particle activity in river water and mud. All 30 water samples contained less than the detectable level of 10 pCi/liter of gross beta-particle activity. All 11 mud samples contained less than the detectable level of 10 pCi/g of gross beta-particle activity.

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Section V. Technical Notes

REPORTED NUCLEAR DETONATIONS, MARCH 1967

During March 1967, the Atomic Energy Commission announced one nuclear test conducted at the Nevada Test Site. This underground nuclear test was conducted on March 2 and was low yield (less than 20 kilotons TNT equivalent).

SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

PLUTONIUM–239 IN TOTAL DIET AND MILK. *P. E. Kauffman* and *P. J. Magno.* Radiological Health Data and Reports, Vol. 8, April 1967, pp. 191–194.

The National Center for Radiological Health initiated a program in July 1965 to determine the level of plutonium–239 in the total diet and milk. The diet samples were obtained from the Institutional Total Diet Sampling Network of the Public Health Service, and the milk samples were obtained from the PHS Pasteurized Milk Network. Using a gastrointestinal absorption factor of 3×10^{-5} as suggested by the International Commission on Radiological Protection, the average amount of plutonium–239 reaching the blood stream from the diet is estimated to be 2×10^{-4} femtocuries per day.

KEY WORDS: diet, foods, Institutional Total Diet Sampling Network, milk, Pasteurized Milk Network, plutonium–239, plutonium–240.

ERRATA

The last sentence of the last paragraph, column 1, (Radiol Health Data Rep 7:683, December 1966), which begins "It is not surprising . . ." should read "It is not surprising that the concentrations of cesium-137 and strontium-90 in Palmer milk are similar to the Pasteurized Milk Network averages (*18*)."

In the February 1967 issue, the amount of xenon-133 released to the atmosphere from the Shippingport Atomic Power station was incorrectly reported (Radiol Health Data Rep 8:133, February 1967), and should read, "During the first half of 1966, a total of 30.4 μCi of xenon-133 was released at Shippingport at concentrations less than the MPC of 3×10^5 pCi/m^3."

The last equation appearing in the article "Precision and Sensitivity of Gamma Spectrometric Measurements in Milk" (Radiol Health Data Rep 7:555-559, October 1966) should be amended. The second part of equation (6) on page 556 should read as follows:

"$s_I^2 = \text{variance of } (G_I - B_I) = (G_I + B_I)/t$"

The following corrections should be made in the article "Radionuclide Levels in Milk, Total Diet, and Human Bone Compared to Federal Radiation Council Estimates, 1965, and 1966

(*Continued on next page*)

Estimates" (Radiological Health Data and Reports 8:65-72, February 1967).

1) Page 67, equation (1)—R=average monthly strontium-90 fallout rate ($mCi/mi^2 \cdot month$).
   b=4.7×10^{-9} $mi^2 \cdot month/g$ Ca (*8*).
2) Page 67, in several places the unit m^2 is shown and should be mi^2—206 mCi/mi^2, (0.33 $mCi/mi^2 \cdot month$), 5.4 mCi/mi^2, 3 mCi/mi^2.
3) Page 68, the last sentence of the paragraph "Strontium-90" should read:
   "The network annual average intakes were 13 pCi/day in 1962, 25 pCi/day in 1963, and 32 pCi/day in 1964, corresponding to approximately 12, 22, and 28 pCi/g Ca, respectively."[2]
4) Page 71, equation (3)—D=dose (rads/year)
   11=conversion constant (kg-rads/mCi-year)

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April 1967

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	tĕr' a
10^{9}	giga	G	jĭ' ga
10^{6}	mega	M	mĕg' a
10^{3}	kilo	k	kĭl' o
10^{2}	hecto	h	hĕk' to
10	deka	da	dĕk' a
10^{-1}	deci	d	dĕs' i
10^{-2}	centi	c	sĕn' ti
10^{-3}	milli	m	mĭl' i
10^{-6}	micro	μ	mi' kro
10^{-9}	nano	n	năn' o
10^{-12}	pico	p	pē' co
10^{-15}	femto	f	fĕm' to

SYMBOLS, UNITS, AND EQUIVALENTS

Symbol	Unit	Equivalent
BeV	billion electron volts	GeV
Ci	curie	3.7×10^{10} dps
cm	centimeter(s)	0.394 inch
cpm	counts per minute	
dpm	disintegrations per minute	
dps	disintegrations per second	
eV	electron volt	1.6×10^{-12} ergs
g	gram(s)	
GeV	giga electron volts	1.6×10^{-3} ergs
kg	kilogram(s)	1,000 g=2.205 lb
km^2	square kilometer(s)	
kVp	kilovolt peak	
m^3	cubic meter(s)	
mA	milliampere(s)	
mCi/mi^2	millicuries per square mile	0.386 nCi per square meter (mCi/km^2)
MeV	million (mega) electron volts.	1.6×10^{-6} ergs
mg	milligram(s)	
mi^2	square mile(s)	
ml	milliliter(s)	
mm	millimeter(s)	
nCi/m^2	nanocuries per square meter	2.59 mCi per square mile
pCi	picocurie(s)	10^{-12} curie=2.22 dpm
R	roentgen	
rad	unit of absorbed radiation dose.	100 ergs per gram

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